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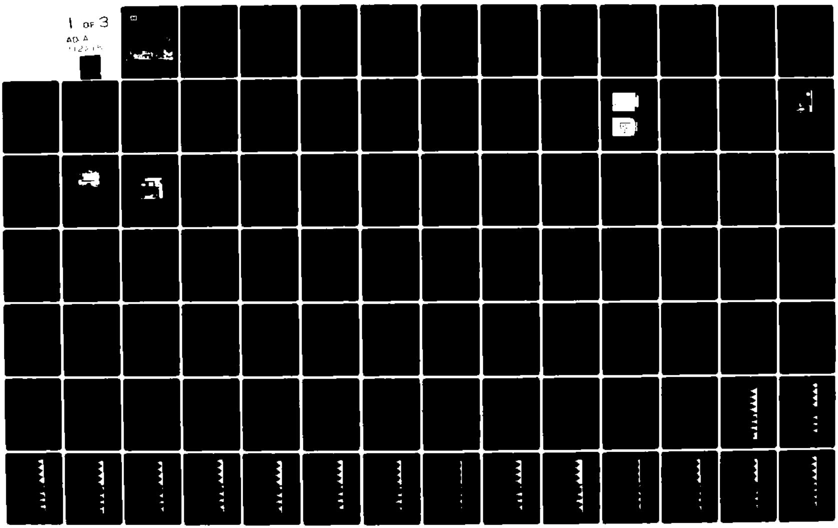

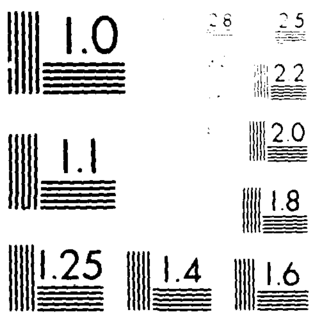
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TECHNICAL REPORT HL-82-3

LOW FRESHWATER INFLOW STUDY

Chesapeake Bay Hydraulic Model Investigation

by

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Hydraulics Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

January 1982

Final Report

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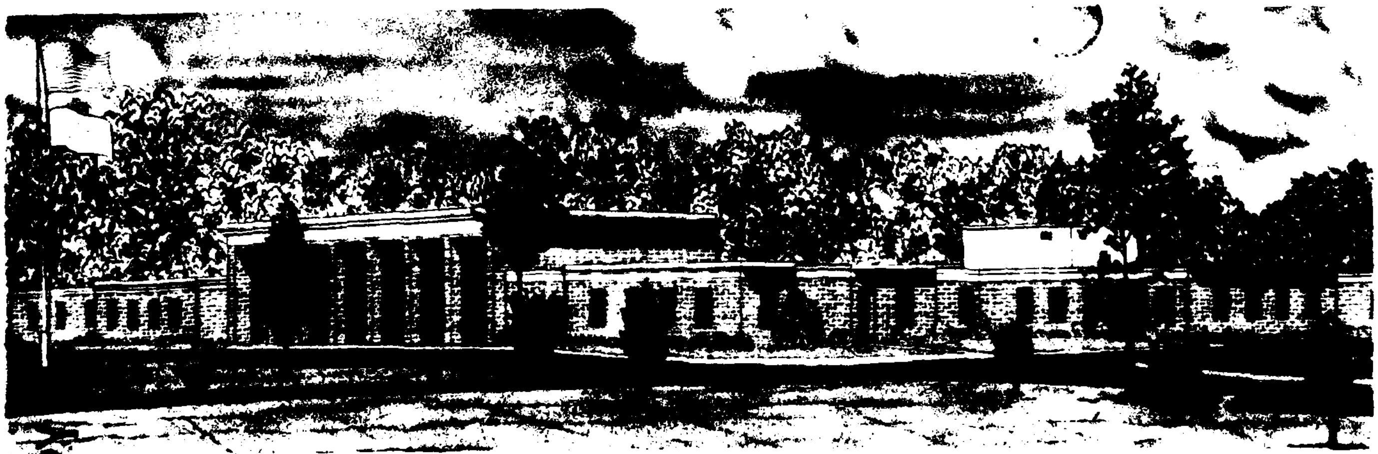

Prepared for U. S. Army Engineer District, Baltimore
Baltimore, Maryland 21203

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Errata Sheet

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LOW FRESHWATER INFLOW STUDY

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Technical Report HL-82-3

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1. Page 29, line 4, second word: Change model to modal.

2. Plates 2 through 22: Crosshatching in first column (-20 to 0) should be solid (black).

3. Plates 35 and 36: Change station numbers in titles from C-01-09 to CB-01-09.

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Future population increases in the Chesapeake Bay area will increase the demand for fresh water from its tributaries. A portion of this demand will be in the form of consumptive losses. In order to predict the impact of these consumptive losses on the Chesapeake Bay and future water resource programs, a study was initiated in a physical model of Chesapeake Bay to compare tide, velocity, and salinity data for a historical period of low flow with data

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20. ABSTRACT (Continued).

resulting from freshwater inflow suppressed by the consumptive losses that may be expected some 50-60 years in the future.

A base test simulating drought water years 1963-1966 was designed to reproduce known low-flow conditions, and a future test was designed to portray water years 1963-1966 combined with anticipated consumptive losses and diversions for 50 to 60 years in the future. Both tests contained a number of consecutively run, average year hydrographs to assess the bay's rebound potential following a drought period.

Sampling for each test resulted in a data set that includes 7 years of continuous hourly tide records at 22 stations distributed throughout the bay, hourly current velocities over complete (13 hr) tidal cycles taken at 16 stations eight times, and approximately 250,000 salinity values during each test. There were 206 salinity sampling stations each having from one to five sampling depths.

Analysis of the data could not address the entire data set; therefore, 32 stations were selected as being representative of the bay and generalizations were made on these stations to assess the effectiveness of the study. Results of the analysis show a general increase in salinity values in the future condition throughout the bay on the order of 1 to 3 ppt. The differences were greater or less locally depending on the station location. Little differences in tides and current velocities were noticed between tests. Variations in vertical salinity structures between spring and neap tide were seen at some stations in the bay, although there was generally little change resulting from the consumptive losses. The bay's rebound after drought conditions was assessed at several stations and the data indicated a return to a state of dynamic normalcy within 3 to 6 months at all stations analyzed for both tests.

PREFACE

A request for the U. S. Army Engineer Waterways Experiment Station (WES) to conduct a hydraulic model investigation of Low Freshwater Inflow Conditions on the Chesapeake Bay was made by the U. S. Army Engineer District, Baltimore. Authorization for the study came under the direction of the River and Harbor Act of 1965.

The study was conducted from September 1979 to March 1980 by personnel of the Hydraulics Laboratory, WES, and its subcontractor Acres American, Inc., under the general direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydrualics Laboratory, Mr. R. A. Sager, Chief of the Estuaries Division, and Dr. J. W. Hayden of Acres American, Inc. Testing was conducted under the supervision of Messrs. D. F. Bastian and R. O. Bruno, Chiefs of the Chesapeake Bay Model Branch, and W. M. Dyok of Acres American, Inc. Project Engineers for the model study included Messrs. R. O. Bruno and D. R. Richards for WES and Messrs. L. F. Gulbrandsen and S. R. Rives for Acres American, Inc. Additional key personnel for WES involved in the model study included Messrs. A. W. Crunk, M. A. Granat, H. J. Rhodes, and Ms. V. R. Pankow. Key personnel for Acres American, Inc., included Messrs. W. E. Hayes, R. T. Lose, P. A. Waltz, and H. W. Whetzel. This report was prepared by Messrs. Richards and Gulbrandsen.

Commanders and Directors of WES during the conduct of this study and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	0.4047	hectares
cubic feet per second	0.02831685	cubic metres per second
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
square miles (U. S. statute)	2.589988	square kilometres

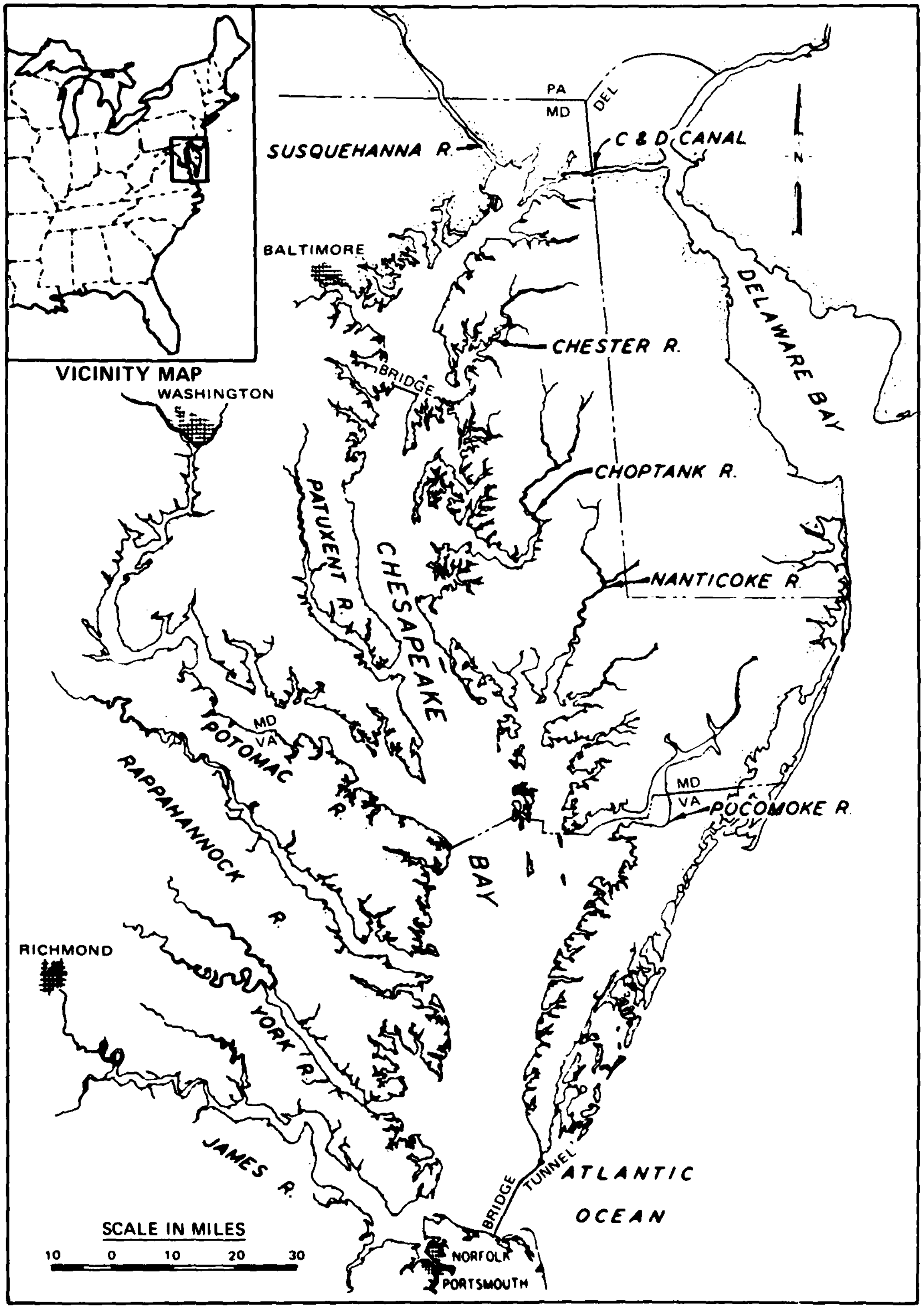

Figure 1. Location map

LOW FRESHWATER INFLOW STUDY

Chesapeake Bay Hydraulic Model Investigation

PART I: INTRODUCTION

Chesapeake Bay

1. Chesapeake Bay with its tributary estuaries forms the largest estuarine system in North America. Between its mouth at the Virginia Capes and its head at Turkey Point, Maryland, the bay is 190 miles* long (Figure 1), has an average depth of just under 28 ft, and has a maximum width of approximately 30 miles.

2. Fresh water from a 64,000-square-mile drainage basin empties into the Chesapeake largely through five major river systems. The James, York, Rappahannock, Potomac, and Susquehanna Rivers provide 90 percent of the freshwater discharge into Chesapeake Bay. Salinity sources to the bay are provided through the Chesapeake and Delaware Canal (C&D Canal) by Delaware Bay to the north and by the Atlantic Ocean to the south.

3. Like most estuaries, Chesapeake Bay is a highly productive biological environment. Freshwater discharge from the various tributary rivers meets with the ocean-supplied salinity within the bay to form the estuarine environment that supports the plant and animal life indigenous to the bay. The abundance of wildlife in the bay, most particularly in the fisheries, plays a significant role in the local economies; this, coupled with the well-known recreational uses of the bay, makes its health important to preserve.

4. Historically, some events have caused considerable stress to the health of the bay. Extreme freshwater inflow variations have caused the occurrence of unusual salinity distributions. Recently (1972),

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

tropical storm Agnes had a most pronounced effect; the high discharges associated with tropical storm Agnes caused a significant freshening of the entire bay. Several plant and animal species showed severe population declines as a result of this extremely high inflow variation.

5. Extremely low freshwater inflow conditions can also have a pronounced effect on the salinity distribution. It is during these conditions that man can perhaps most significantly affect the health of the bay through his activities. When flows become very small, the amount of freshwater that man removes and redistributes becomes proportionately large. As a result, during these low-flow periods the amount of freshwater used by man may have a larger impact on the bay than during high-flow periods when man's effect on inflow is small by comparison. It is important to understand these low-flow periods as they represent a sensitive time in the health of the bay. Unless the behavior of the bay is understood during these periods, it would be difficult to design or implement a management scheme to preserve the health of the bay with any degree of confidence.

Purpose

6. The purpose of the Low Freshwater Inflow Study (LFIS) was to acquire knowledge of how Chesapeake Bay responds to historical low freshwater inflow conditions and how the bay would respond to projected future low-flow conditions when the consumptive use of fresh water by man has increased. Specifically, the study had the following objectives:

- a. To define salinity patterns throughout the bay system resulting from both historical and projected drought conditions on all bay tributaries.
- b. To determine the effect of "consumptive freshwater losses" on an "average" year hydrograph designed to produce long-term average salinity.
- c. To define a recovery time for the bay to return to "normal" salinities following a drought condition.
- d. To provide the hydrodynamic data necessary to develop salinity-inflow relationships.

7. A more general purpose of the test was to generate a large data

set for historical low-flow conditions that both biological and physical scientists could use to do further in-depth research into estuarine mechanics. This data set could be used to do analyses that would be too costly to do in the field.

Scope

8. The LFIS consisted of two separate tests that had identical boundary conditions with the exception of freshwater inflows. The "Base Test" was designed to reproduce hydrographic conditions observed in the prototype during water years (WY) 1963-1966. The "Future Test" was designed to reproduce the WY 1963-1966 hydrographic conditions combined with anticipated consumptive losses and diversions for 50 to 60 years in the future. Each test was followed by at least 3 years of average inflows.

9. Hydrograph conditions for the Future Test were identical to the Base Test conditions except that consumptive freshwater losses projected by the U. S. Army Engineer District, Baltimore (NAB), were superimposed. These losses varied from inflow to inflow and from week to week.

10. Desired inflows for sewage treatment plants were also different between tests. Sewage treatment plant discharges were typically higher in the Future Test reflecting increased plant discharges due to increased populations.

PART II: PROTOTYPE

11. Chesapeake Bay is located on the east coast of the United States. The 190-mile-long estuary varies in width from 4 to 30 miles with an average depth of 28 ft; the surface area of the bay is approximately 4,400 square miles. The mean annual discharge of its 126 freshwater tributaries is approximately 70,000 cfs, almost 90 percent of which is contributed by five major drainage basins: the Susquehanna, the Potomac, the Rappahannock, the York, and the James. The Atlantic Ocean provides salt water to the system, producing large salinity variations within the bay. The eastern shore is generally saltier than the western shore, attributed in part to the dominance of freshwater flow from the western tributaries and to the right-hand tendency of flow contributed by Coriolis acceleration.

12. Chesapeake Bay is classified geologically as a drowned river valley estuary. The Holocene sea-level rise inundated the Susquehanna River Valley to form the bay. Sedimentation from the tributaries as well as erosion of the banks has contributed to maintaining the bay's broad shallow character. The bay is classified as a partially mixed estuary, although various stages of freshwater discharge and tidal and wind mixing cause portions to alternate between well mixed and highly stratified. Tides are semidiurnal with mean ranges from 1 to 2 ft. The length of the Chesapeake Bay is such that a complete tidal wave is contained within its limits at all times. Wind-generated waves are generally less than 3 ft in height, but large waves can occur during high wind conditions. Average maximum velocities for tide and wind-driven currents range from 0.5 to 3 fps.

PART III: CHESAPEAKE BAY MODEL

Physical Model Description

13. The physical model of Chesapeake Bay is located on Kent Island in Matapeake, Maryland. The model is an 8.6-acre fixed-bed model molded in concrete to conform to the most recent National Ocean Survey charts. At the time of this study, all major ship channels had been molded with the proposed 50-ft channels leading into Baltimore and the existing channels elsewhere. The molded area of the model extends from approximately 30 miles offshore in the Atlantic Ocean to the heads of tide for all tributaries emptying into the Chesapeake. The entire length of the C&D Canal and a portion of Delaware Bay are also modeled. Overbank geometry is reproduced to the +20 ft contour. Model limits are shown in Figure 2.

14. The hydraulic model was designed based on the equality of Froude numbers, model to prototype, reflecting similitude of gravitational effects. The Froude number, $\mathbb{F}$, is defined as:

$$\mathbb{F} = \frac{V}{\sqrt{gd}}$$

where

V = velocity

g = gravitational acceleration

d = characteristic length

For distorted-scale models the characteristic length, d , is taken to be the vertical dimension or depth. Geometric scales of the model are 1:1000 horizontally and 1:100 vertically, reflecting a distortion ratio of 10:1. These dimensions and Froudian model laws defined the following model-to-prototype ratios:

Characteristic	Ratio
Vertical length	1:100
Horizontal length	1:1000

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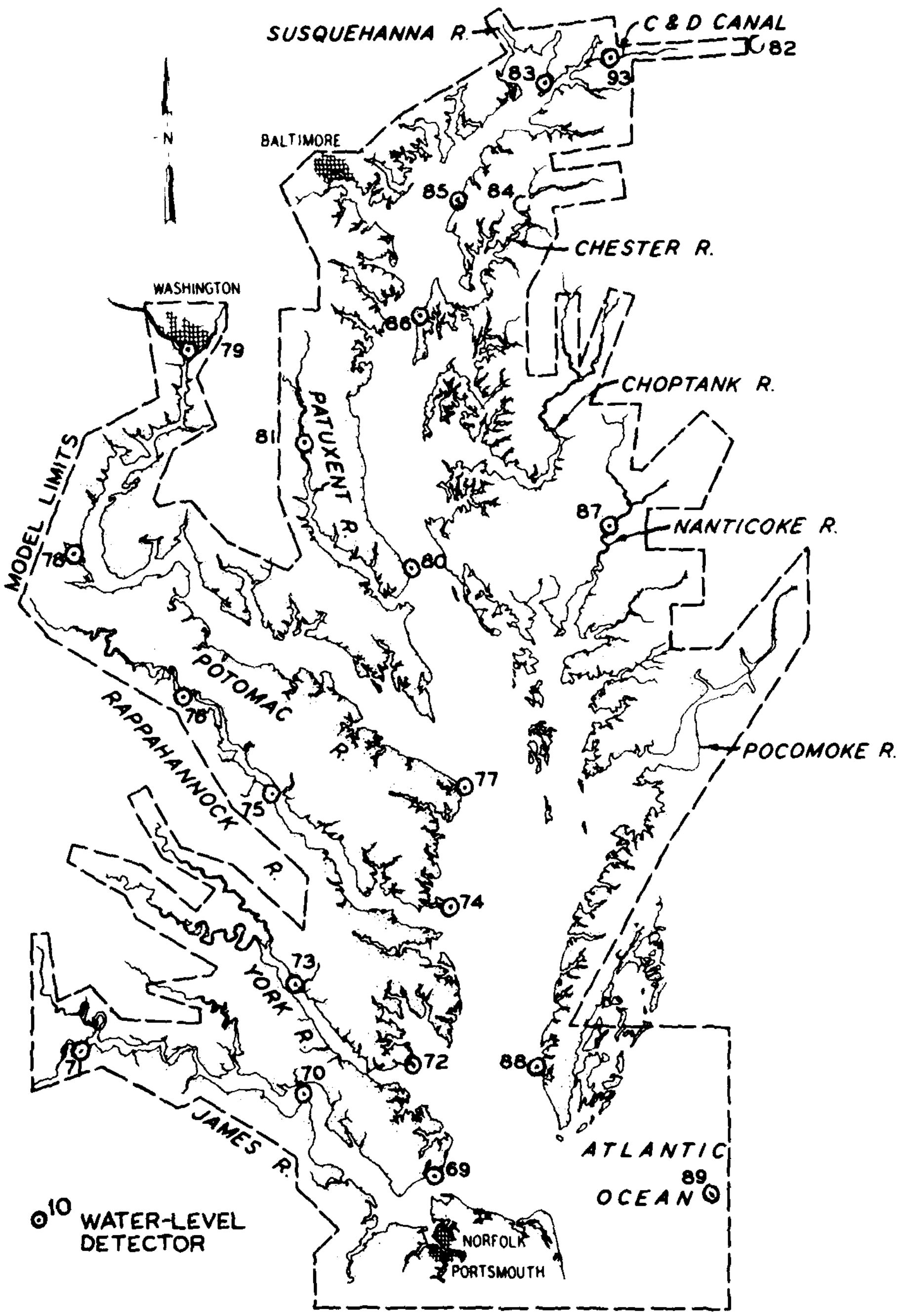

Figure 2. Model limits

Characteristic	Ratio
Slope	1:10
Time	1:100
Velocity	1:10
Volume	1:100,000,000
Discharge	1:1,000,000

The model-to-prototype ratio for salinity is 1:1. This is the general practice for distorted-scale models.

15. The model was designed and equipped so that selected prototype boundary conditions could be simulated and the model response to these conditions recorded. A discussion of appurtenances necessary to generate and record test boundary conditions follows.

Computer Facilities

16. The Chesapeake Bay model is equipped with two Texas Instruments (TI) minicomputers that are used for model control, data acquisition, and data analysis and an IBM 5110 minicomputer that is used for software testing and various smaller data analysis tasks using the APL computer programming language. The TI 960 is a 64K minicomputer used solely for model control and data acquisition. It is equipped with a 2.5-megabyte magnetic disc that contains all necessary system software to compile and run the model control computer program. It also is equipped with two 250K flexible disc drives that are used to input tidal and hydrographic boundary conditions for each test as well as to record data from 94 different flowmeters and water-level detectors throughout the model. Output from these devices is displayed on a cathode-ray tube (CRT) or hardcopy terminal where it can be observed by the model control computer monitor at the same time that it is recorded on flexible disc. Through the model control terminal, the computer monitor can interactively observe model operations by displaying values from any combination of model control devices.

17. The TI 980 is a 56K minicomputer used solely for data analysis. It has the same access to the magnetic disc and flexible discs as does the TI 960. In addition, it can interface with a 300 card per

minute card reader, a 9-track, 800-bpi (bytes per inch) magnetic tape drive, and a Versatec electrostatic printer/plotter. Graphics for this report were largely supplied by the Versatec machine.

18. The IBM 5110 is a 32K minicomputer equipped with a standard APL keyboard. It is used primarily for testing various data sorting and analysis functions prior to their use on time-sharing systems. It is also used on smaller and less sophisticated data analysis tasks.

19. When the data set for a particular test is too large for the in-house computers, the model has the capability of using time-sharing services through landline telephone communications. The LFIS test data set was sufficiently large, with over 2 megabytes of salinity data, to require time-sharing services. The size of the data set, coupled with the need for interactive editing, dictated the choice of APL as the programming language to be used on the data of this test.

Tide Generation and Measurement

20. Source tides in the model can be generated by using the primary tide generator in the model ocean and by using the secondary tide generator in the Delaware Bay at the eastern end of the C&D Canal. Both tide generators can be operated to generate a repetitive tide or by using the TI 960 model control computer a repetitive or variable tide can be generated.

21. The TI 960 computer controls the source tides by providing a continuously changing programmed voltage to the tide-generating mechanisms. These mechanisms consist of a feedback system that is entirely self-contained and is not dependent on computer feedback for adjustment. The system consists of a tide control amplifier that conditions the computer signal and a bubble tube positioner that senses the water-level position and positions the hydraulically controlled inlet and outlet gates via a hydraulic pilot regulator. Figure 3 is a schematic of the tide generation system. A more detailed description of the

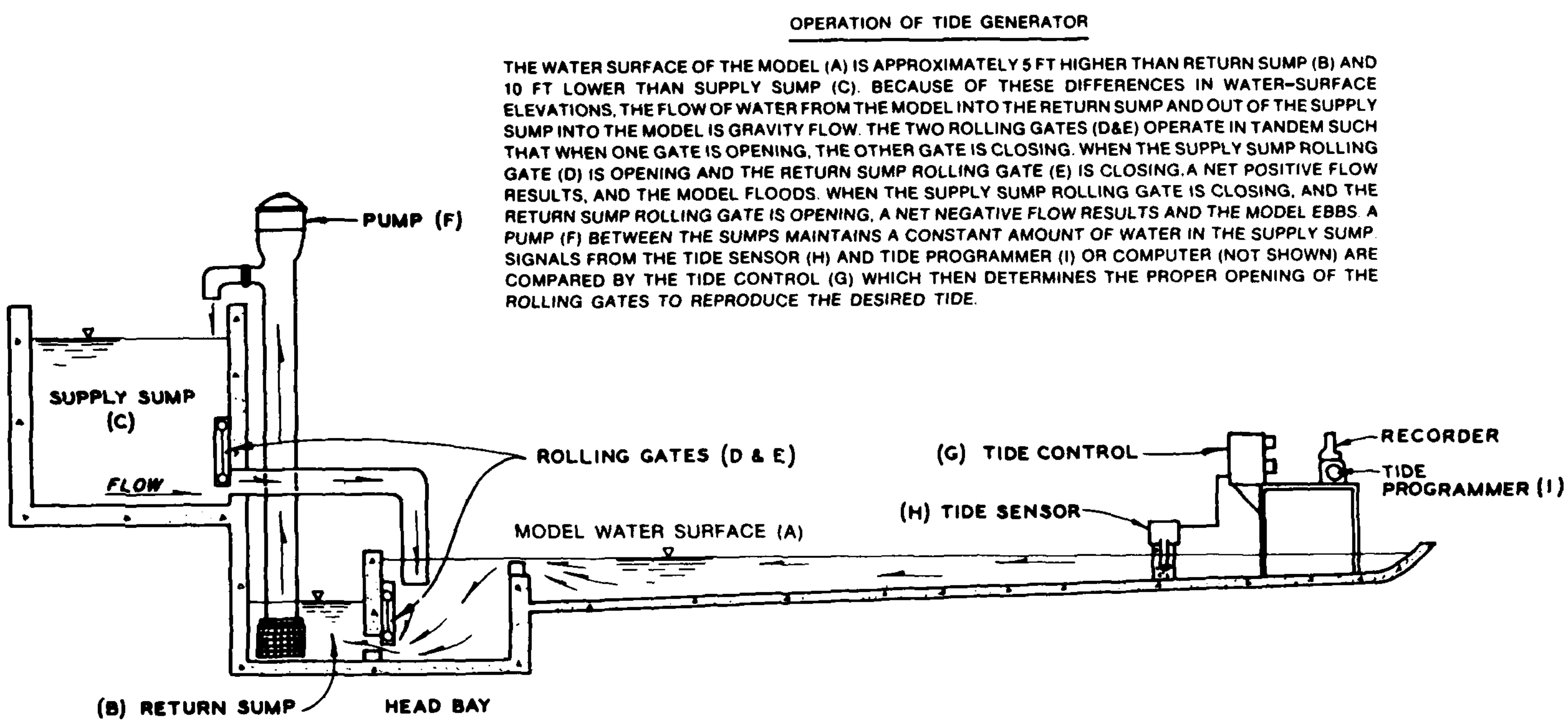

Figure 3. Tide generation system

tide generators can be found in Scheffner et al. (1981).*

22. Water-surface elevations throughout the model can be measured both manually by 75 distributed point gages, and automatically by 22 water-level detectors (WLD), which report their individual water levels to the computer where they are stored. Water-level elevations are monitored both manually at the ocean and automatically throughout the model during testing (Figure 2). Manual measurements at the ocean were used to check automatic devices.

Freshwater Inflow

23. The Chesapeake Bay model is capable of reproducing a variable hydrograph freshwater inflow through the use of positive feedback control of river discharges. Fresh water enters the model at 21 independent inflow points representing the major tributaries of the prototype. Figure 4 is a map of the bay showing the positions of the discharge points. The Susquehanna River required two inflow systems (Nos. 15 and 22) due to the range of freshwater inflow. As shown in Figure 4 both these systems lead to the same discharge point.

24. Twenty-one rivers were chosen to represent the total combined flow of more than one hundred separate tributaries for several reasons. Providing a separate discharge point at each minor tributary is impractical. The sophisticated plumbing and equipment necessary for each inflow are expensive and require specialized maintenance. Many of the tributaries provide infinitesimal flows, immeasurable with the present system used. These flows are summed with the nominal discharge of the closest of the 21 chosen tributaries to provide a representative and well-balanced, as well as a cost-effective, inflow distribution.

25. Flow is controlled at the discharge points by an arrangement of solenoid-controlled discharge ports with graduated orifices. An

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* Norman W. Scheffner et al. 1981 (Dec). "Verification of the Chesapeake Bay Model; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-81-14, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

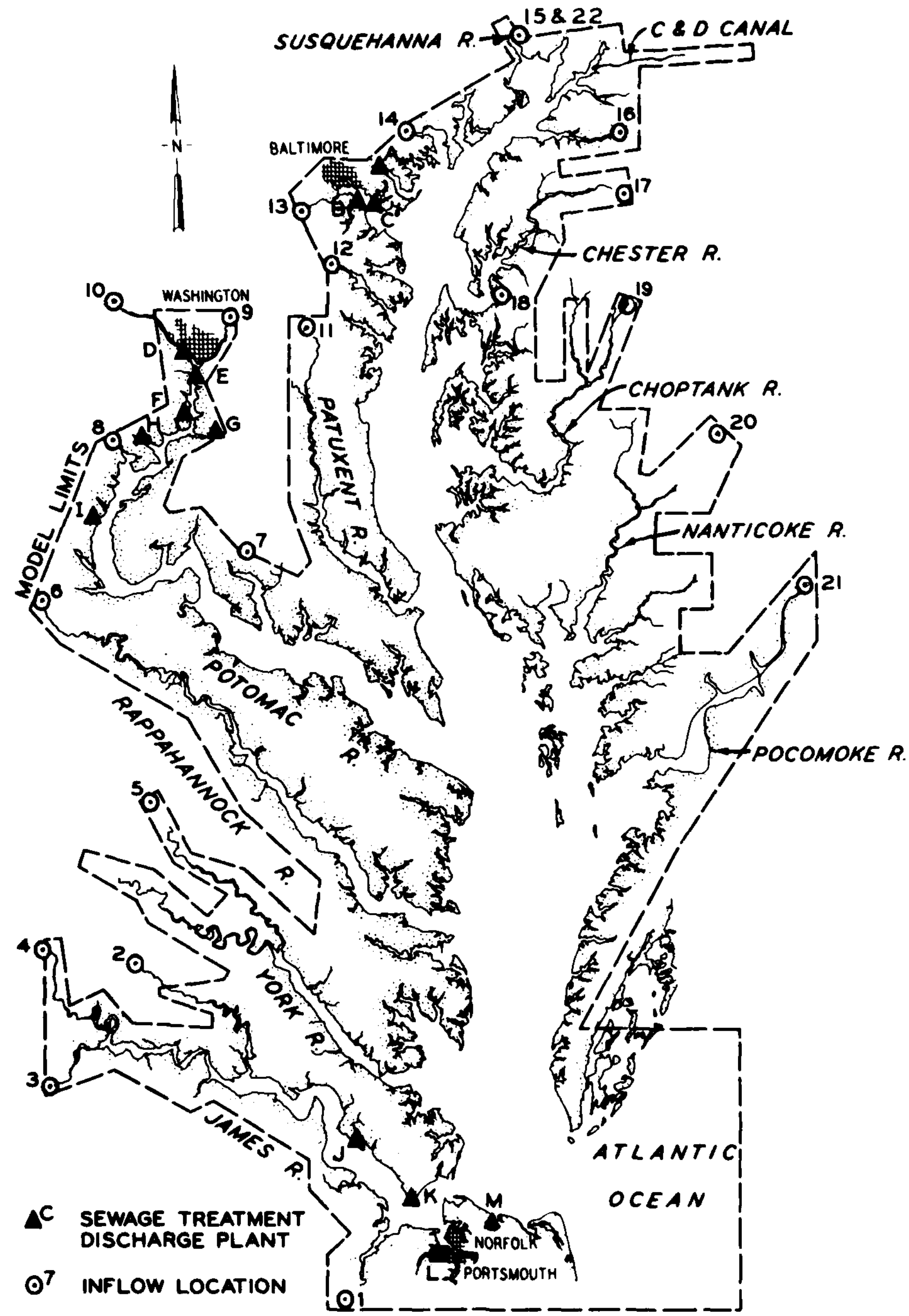

Figure 4. Freshwater inflow and sewage treatment plant locations

electrical signal causes a solenoid to be activated, fully opening a discharge port. The configuration of the graduated orifices is such that 4096 combinations of open and closed ports provide a range of flows which can be stepped from the smallest measurable flow to the individual tributary's maximum theoretical flow. These arrangements of ports are called digital valves.

26. Flow from the digital valves to the model is monitored continuously by bearingless flowmeters of varying ranges that can be used alone or in combinations to provide accurate flow readings covering the full range of a tributary's discharge. The flowmeters use fiber optics to count the revolutions of a water-driven rotor. Optical pulses are translated to electrical pulses that are summed on an arrangement of totalizers and latches on a counter card. This counter is strobed at predetermined intervals which causes the summed value of pulses to be transferred to a transmitter and the latches cleared for the next summation. During the LFIS, inflows were strobed every 18 sec, or every half hour of prototype time; thus, the values available for flow calculations are not instantaneous flows but are 18-sec averages.

27. Each flowmeter in use has its own transmitter where the binary totals from the counter are translated to ASCII code and transmitted to the TI 960 model control computer in serial form via a hard-wired cascading multiplexed 20-milliamp current loop communication system.

28. In the computer, the pulse totals are transformed to flows using a linear regression derived from pretest calibrations for each flowmeter/digital valve combination. The computer then compares these 18-sec averaged flows with the desired flows for each flowmeter and determines whether the digital valve setting should be adjusted at any of the inflows. The feedback system is activated when there is a discrepancy between the desired flow and the actual flow. Discharge ports are opened or closed to adjust the actual flow toward the desired flow. Time-averaged discharges controlled in this manner remain very close to the desired hydrograph step values. Some overshooting of flows may occur at the beginning of each step as the computer overadjusts, but flows are

generally stable within a few update cycles and are near desired flows very quickly. This varies, of course, with the magnitude of the step change as well as with each individual flowmeter/digital valve combination. Figure 5 shows a typical inflow system used in this test.

Sewage Treatment Plants

29. For the LFIS, changes in discharges of the rivers were supplemented by modeling major sewage treatment plants (STP's) in three of the bay's largest urban centers. Figure 4 shows the locations of 13 STP's modeled for the study. Table 1 is a list of the stations with their geographical locations. Discharge A is located on the Back River; discharges B and C are located on the Patapsco River, all near Baltimore, Maryland; discharges D through I are located in the upper reaches of the Potomac River, near Washington, D. C.; and discharges J through M are located on the James River in the Norfolk-Newport News, Virginia, area. Engineering drawings of the STP's were consulted and the discharge points were located as near as possible to those in the prototype. Fresh water was used as the discharge medium in all modeled STP's. Since near-field flow patterns are not easily modeled in a distorted-scale model, and since near-field structure was not an object of concern, no attempt was made to reproduce the injection methods of prototype. Brass diffusers were fitted to nylon tubing for outfalls. Figure 6 shows a typical portable inflow as used in the LFIS. A constant-head tank, approximately 10 ft above the model, feeds an array of adjustable rotameters which in turn feed the nylon discharge lines. Flow rates through the STP's were adjusted manually, as required, throughout each hydrograph test.

Saltwater Supply System

30. A constant source salinity is provided to the model ocean by maintaining the supply sump (Figure 3) at the desired salinity. This is accomplished by adding sufficient quantities of saturated brine

Figure 5. Typical inflow system

Figure 6. Typical STP

(approximately 280 ppt) to the return sump where it is mixed to the desired source salinity prior to being circulated to the supply sump and thence to the model ocean. The saturated brine solution is obtained by injecting fresh water into a bed of granular salt (NaCl) from which it is later released to the return sump in measured quantities. The salt-water supply system is capable of maintaining source salinity to within 0.2 ppt of that desired in steady-state conditions and to within 0.5 ppt of that desired during hydrographic conditions.

Bubbler System

31. The bubbler system in the model is designed to create a more realistic vertical salinity distribution. Since nonastronomical mixing energy (primarily wind) is not easily modeled by tides and supplemental roughness alone, it was necessary to add the bubbler system in order to maintain closer agreement with the vertical salinity distribution in the prototype.

32. The model bubbler system consists of a network of copper tubing placed along the axis of the bay and its major tributaries (Figure 7). The tubing is charged with a constant air pressure and releases bubbles into the water column at a constant prescribed flow rate. Throughout any given test the bubble flow rate, air pressure, and bubbler depth in the water are monitored for consistency.

Current Meters

33. Current velocity measurements were made with miniature Price-type meters (Figure 8). The center line of the model cups on the meter was about 0.04 ft above the bottom of the meter frame. The overall width of the meter was about 0.1 ft in the model, representing a horizontal width of about 100 ft in the prototype. Therefore, distortion of the horizontal area (model to prototype) resulted in model velocities averaged over a much larger area than those of the prototype point observations. The same was true for the vertical area since the height of

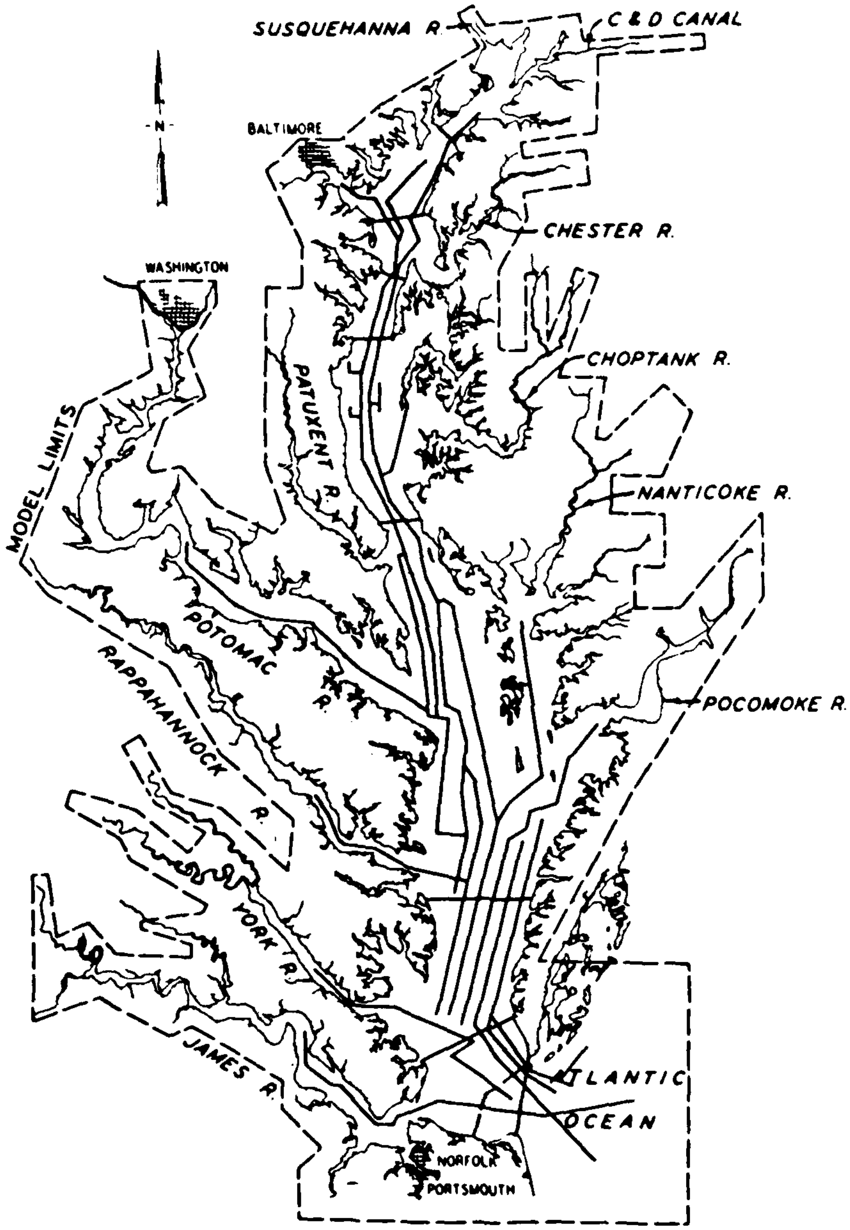

Figure 7. Bubbler system layout

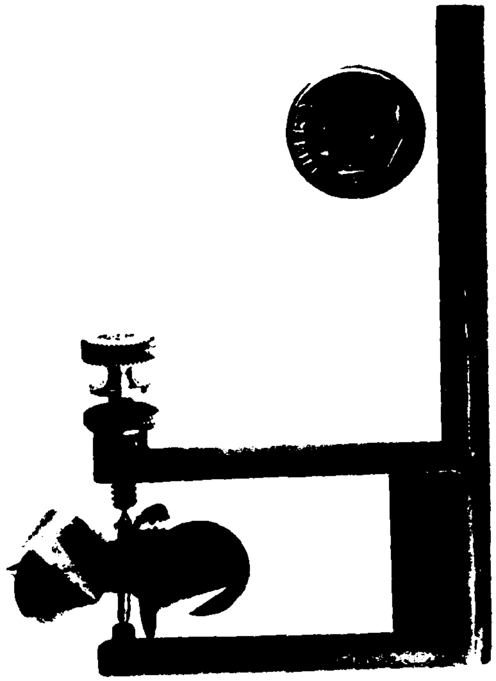

Figure 8. Miniature Price-type
current meter

the cups on the meter was equivalent to about 4.0 ft prototype. Velocities were obtained by counting the number of revolutions the meter made in a 10-sec interval (model) which was equivalent to about 17 min in the prototype. The meters were calibrated frequently to ensure the accuracy of measurements and were capable of measuring actual velocities as low as about 0.03 fps (0.3 fps prototype). Accuracy of these meters was about $\pm$0.15 fps (prototype).

Vacuum Sampling System

34. Salinity samples for this test were taken using a vacuum aspiration system. A series of vacuum pumps provide a continuous vacuum to three valve manifolds. A total of 15 valves control a varying number

of cotidal stations arranged such that sampling times are never more than 1/2 hr from the desired slack-water sampling time. In each case, the sample is pulled at the same time relative to slack water. The sampling station consists of a sampling probe built from a number of separate copper tubes soldered together to form a multidepth probe. These copper tubes are attached to short lengths of plastic tubing that leads to individual 10-ml test tubes. Vacuum is provided to the tubes by a vacuum/overflow jar that provides even vacuum to all lines. This system has proven effective in taking a very large number of samples. The filled test tubes are removed manually from the sampling device between sampling times and placed in special racks for later analysis.

Salinity Testing System

35. For the LFIS a new salinity testing procedure was developed due in large part to the number of samples required. Previous testing methods would have required a severely reduced schedule or extremely high manpower costs. A new semiautomatic data logging system was acquired that reduces testing time, thereby freeing personnel for other tasks, and results in better resolution of salinity values, thus increasing confidence in the data.

36. Beckman RA-5 solumeters have been used continuously for conductivity measurements since testing began (Figure 9). These meters use a salinity probe shaped like an eyedropper into which a sample is drawn and the salinity read from an analog meter. These analog meters provide much opportunity for error in reading and transcription, and even the most experienced operators are unable to be more accurate than 2 percent of full scale, which is 0.8 ppt. The solumeters provide a voltage output of 0 to 100 mV which is proportional to 0 to 100 percent of full scale. This voltage is used to drive a digital voltmeter which measures 0.1 mV giving a resolution of 0.1 percent of full scale or 0.04 ppt. In calibrating the meters, it was found that a given salinity standard could be repeated to within approximately 0.3 percent or 0.12 ppt. This is in an ideal situation where temperatures, conductivity,

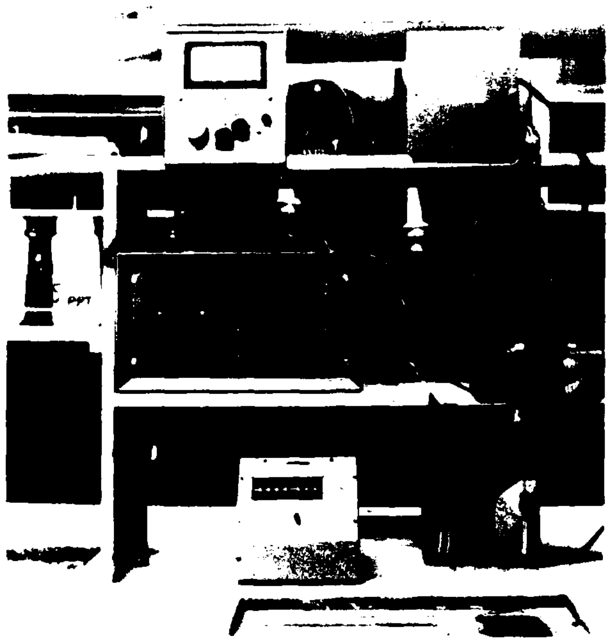

Figure 9. Beckman solumeter

and probe residence time are carefully controlled. Other tests performed on the meters indicate that most samples can be relied upon to within approximately 0.5 ppt. There are some cases where operator error or electronic problems can cause larger deviations, but these are detectable and can be isolated from the data set or corrected.

37. The data logging system (Figure 10) enters the values, converted by the digital voltmeters, on cassette tape in ASCII code where it can be processed by the TI 980 minicomputer for storage. With each sample value, pertinent information such as depth, time, tide, and station name is added to the record. This can all be accomplished with a minimum effort on the part of the meter operator. Direct entry of values on cassette tape precludes the need for keypunching and the possibility of misinterpretation with each transfer to a different medium.

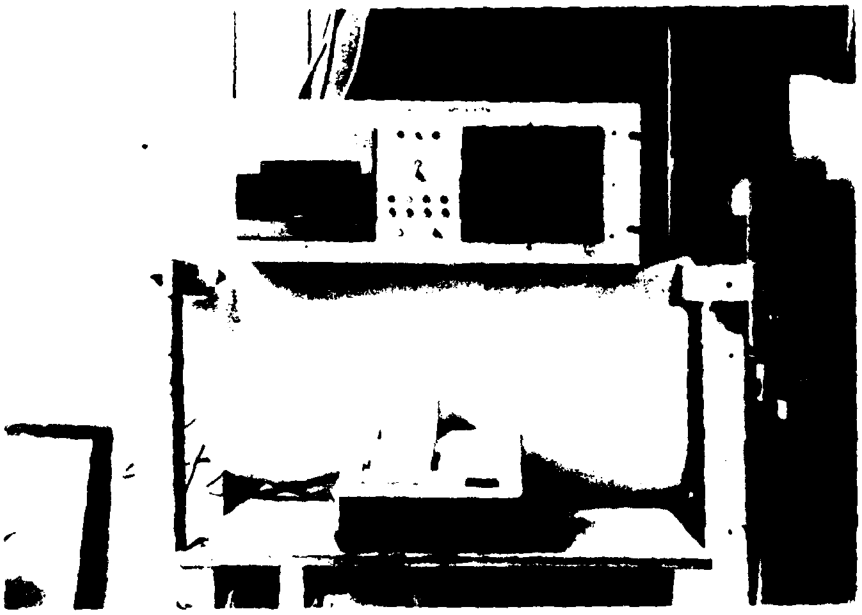

Figure 10. Data logger

PART IV: TEST CONDITIONS

Introduction

38. The accurate control of boundary and initial conditions in any model test is of obvious importance to the test if any degree of significance is to be attached to the results. This is particularly true for base versus plan testing where model response should be related entirely to designed base versus plan differences rather than any perturbations in desired boundary control.

39. The boundary and initial conditions in both the Base and Future Tests were designed to be identical with the exception of the Future hydrograph being suppressed by what is defined as consumptive freshwater losses. If all boundary and initial conditions with this exception were identical, the resultant Base versus Future Test data differences could be attributed to these consumptive losses. However, in any physical model test, perturbations in the boundary and initial conditions occur. It is important to be able to explain whether or not Base versus Future differences were a result of boundary and initial value differences or if they were truly a result of consumptive losses.

40. Small boundary and initial condition differences other than freshwater inflow rates occurred during these tests. These differences, however, appear to be too small to explain the different model salinity responses in the Base and Future Tests. A more detailed discussion of test boundary conditions and procedures follows.

Tides

41. Source (ocean) tides in the Chesapeake Bay model consist of a repetitive, 28-lunar-day, 56-cycle tide sequence that was constructed from records acquired at Old Point Comfort, Virginia.* The tide is based on the equation:

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* Harmonic analyses of the recorded data were performed to provide a 12-constituent ocean source tide.

$$h(t) = \sum_{i=1}^{12} a_i \cos\left(\frac{2\pi}{T_i} t - \phi_i\right)$$

where

$h(t)$ = tide height

a_i = constituent amplitude, ft

t = time, hr

T_i = constituent period, hr

ϕ_i = constituent phase, rad

The following are the constituent values:

No.	Constituent	Amplitude (a_i)	Period (T_i)	Phase (ϕ_i)
1	M2	1.188	12.421	3.6908
2	S2	0.230	12.0000	4.1068
3	N2	0.265	12.6584	3.3879
4	K1	0.170	23.9344	1.7392
5	O1	0.146	25.8194	2.1972
6	V2	0.051	12.6260	3.3728
7	M1	0.006	24.8332	2.2321
8	J1	0.012	23.0985	2.0307
9	Q1	0.020	26.8683	1.9488
10	P1	0.048	24.0659	1.8336
11	L2	0.033	12.1916	3.2304
12	K2	0.059	11.9672	4.0534

42. Tide 1 of the cycle, which has the greatest amplitude of the 56 tides, had a high water of +2.2 ft and a low water of -1.8 ft for a total range of 4 ft. Tide 18, a typical neap tide, had a range of 2.07 ft (from +1.17 ft to -0.90 ft). Figure 11 is a graphic representation of the 56-cycle tide computed from the above constituents. This tide is propagated up the bay and reaches Reedy Point, Delaware, at the Delaware River end of the C&D Canal 16.26 hr later.

43. The test began with the lead-in period maintaining a constant amplitude spring tide which reflected the values of tide 1

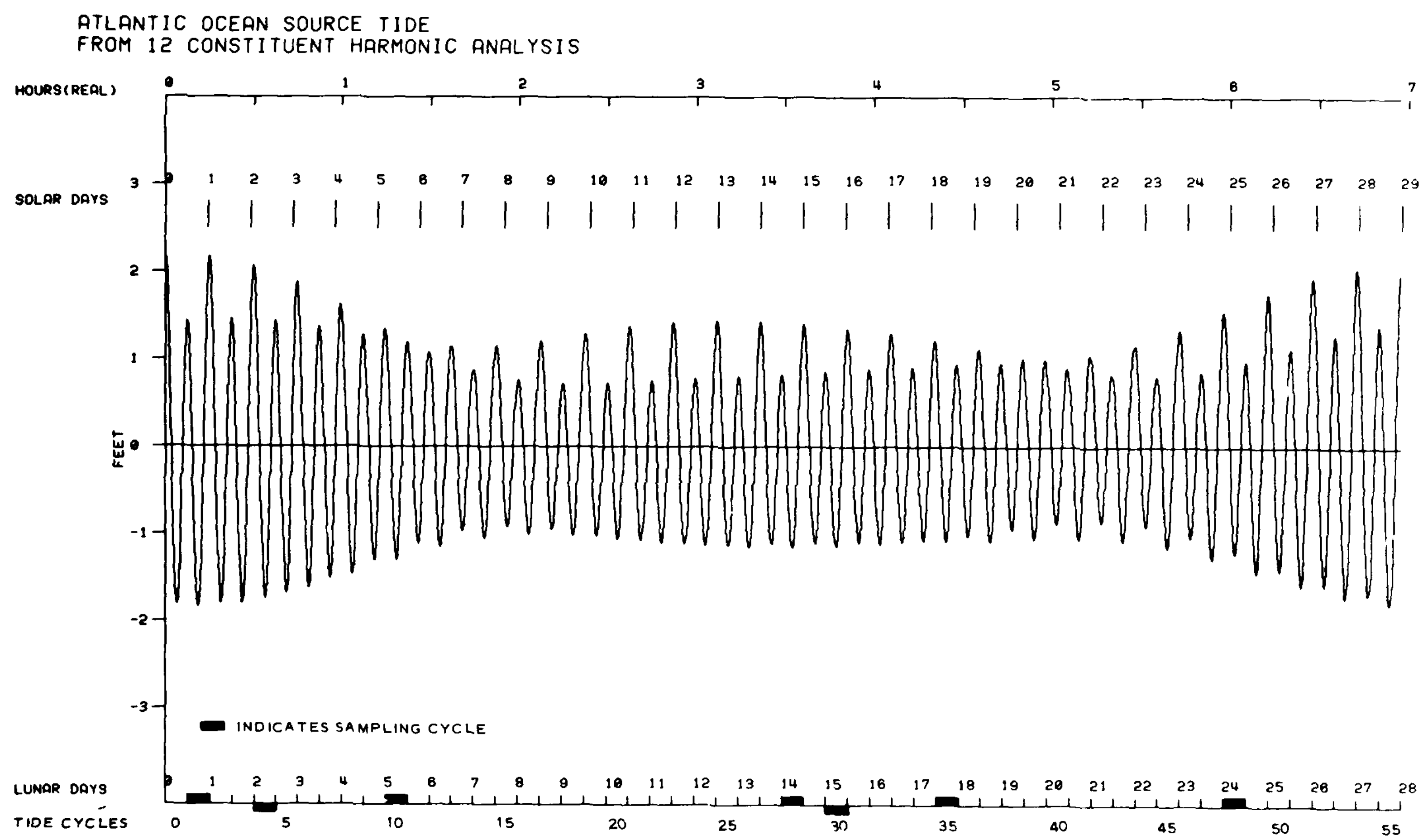

Figure 11. Ocean source tide

(+2.2 ft/-1.8 ft). This condition, with the constant discharge, further enabled the model to come to a density equilibrium. At the start of the hydrograph period, the 28-day variable tide was implemented and maintained throughout the test.

44. The ocean tide control amplifier was calibrated prior to each test to give the correct lead-in tide. The water level at the ocean tide control station was monitored continuously by a water-level detector (WLD) which was hard-wired to the computer and to a strip chart recorder where real-time visual inspection of tide shape could be accomplished. In addition, manual point gage measurements were taken twice per 56-tide period on tides 7 and 8 and on tides 35 and 36 to confirm water levels indicated by electronic measurements.

45. The Delaware Bay source tide was not used for these tests for two reasons. First, available prototype data are inadequate to define the amplitudes and periods of the source tide and salinity under variable tidal conditions in Chesapeake and Delaware Bays. Second, previous testing in the model* had shown that the hydrodynamics of the C&D Canal are very sensitive, particularly to variations in mean water-surface elevation, so that even minor discrepancies in boundary control of water-surface elevations have significant impact on canal hydrodynamics and thus on salinities in the Upper Bay. Since the boundary control for the source tide in Delaware Bay was not capable of preventing small discrepancies in water-surface elevation, it was decided not to reproduce the source tide for these tests so that any changes in Upper Bay salinities from the Base Test to the Future Test would not be erroneously affected by possible discrepancies in boundary control.

Freshwater Inflow

46. The LFIS hydrograph can be divided into four distinct portions:

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* M. A. Granat, L. F. Gulbrandsen. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation" (in preparation). U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

a constant inflow period for salinity stabilization (before week 0), a 1/2-year lead-in hydrograph (week 0-24), a 3-1/2-year hydrograph with drought years low inflows (week 25-209), and a 3- or 4-year hydrograph of model (average) years (week 210-416 for the Base Test and week 210-264 in the Future Test). Hydrographs for the total bay and each inflow point are shown in Plates 1-22. Both tests began with a steady-state discharge to provide a constant inflow distribution for reaching a stable density distribution. The Base and Future Tests began with a 70,000-cfs nominal total bay discharge which represents a long-term average flow. Distribution of the discharge by percent and by flow rate is provided in Table 2.

47. When the model was determined to have reached a stable density distribution, a lead-in hydrograph, simulating the first 24 weeks of WY 1963 (beginning on day 270 of calendar year 1962), was implemented. This portion of the hydrograph was intended to be identical in both Base and Future Tests in order to provide a more realistic density structure for the beginning of the salinity testing period.

48. At week 25 the hydrograph continued to simulate the second 6 months of WY 1963, and WY 1964, WY 1965, and WY 1966 in the Base Test, and the same hydrograph sequence reduced by increased consumptive losses in the Future Test. Consumptive losses projected by NAB varied from inflow to inflow and from step to step. Baywide total consumptive losses averaged about 2400 cfs throughout the test, or approximately 4.5 percent of the total bay discharge, percentages being generally greater during periods of low flow and less during periods of high flow.

49. Week 210 began the fourth portion of the hydrograph which consisted of a series of "modal" water years designed to produce long-term average salinities in the model. The modal hydrograph is based on a rather complicated selection of monthly averaged flows for each inflow point; this results in a smoothed increasing and decreasing flow. This hydrograph is concerned with seasonal flows rather than the reproduction of a realistically spiked hydrograph. The modal hydrograph was reproduced four times in the Base Test, following WY 1966, and three times in the Future Test. As with the preceding hydrograph, the Future

modal WY is affected by the same order of magnitude of increased consumptive losses.

50. Observed freshwater discharges in the model for both Base and Future Tests followed the desired freshwater discharges within a 10 percent error band most of the time. Of more importance to this test, however, was how the desired Base-Future differences compared with the observed differences. The majority of inflows maintained the desired Base-Future difference (Plates 2-22). There were three instances when flow problems developed that could negatively impact comparisons of the test at these points:

a. Step 266 at Inflow 15 - Surge in flow added excess water to the model in the Future Test. Flow was recorded at 75,000 cfs for one-sixth of a step. Desired flow for this period was 21,286 cfs.

b. Step 269 at Inflow 15 - Surge in flow added excess water to the model in the Future Test. For the first two days of this step, the flow was approximately 80,000 cfs. Desired flow for Step 269 is 29,386 cfs.

c. Step 114 at Inflow 4 - Surge in flow added excess water to the model in the Future Test. Flow of 9,818 cfs observed for the entire step. Desired flow for Step 114 is 6,243 cfs.

Steps 114, 266, and 269 were of some concern when looking at salinity differences between tests and at differences in stratification. Within very short periods, large excess amounts of fresh water were injected into the model in the Upper Bay and the upper end of the James River and may have affected salinities for some time afterward. Weekly averaged calculations of STP's indicated no significant departures from the desired flows in either test.

Current Velocities

51. Velocity measurements in the LFIS were chosen to represent seasonal velocity profiles at 16 stations (Figure 12). The task required measurements at from one to three depths on one spring and one neap tide each, during high and low flows in WY 1965 and once each during the modal year. April (high flow) and June (low flow) were selected as the

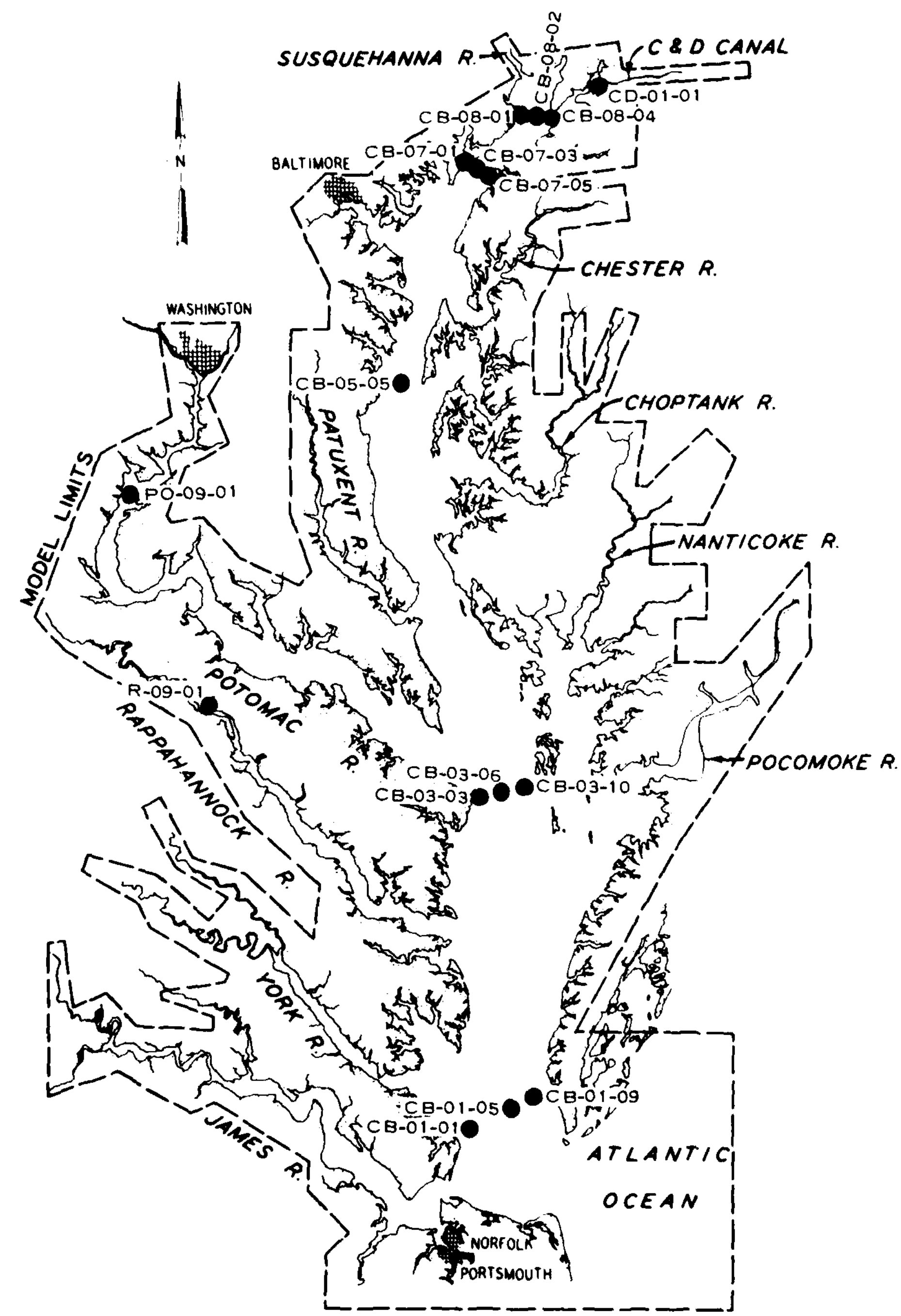


Figure 12. Velocity sampling stations

representative discharge periods during WY 1965 and lunar days 1590-1599 were chosen as the representative high-flow period during the modal year. Velocity measurements were obtained at hourly intervals over a tidal cycle (13 solar hours) throughout each of the measurement periods.

52. Velocity measurements were taken with miniature, cup-type, rotary velocity meters that were described in paragraph 33. Meter friction is kept to a minimum by keeping the bearings as clean as possible; however, there is still a critical velocity at which initiation of rotor movement occurs. This velocity varies slightly from meter to meter and from test to test, but is generally on the order of 0.3 fps. Below this value velocities cannot be accurately measured; although by visual observation, it can be determined that the water is moving and in which direction. The meters were carefully calibrated prior to testing in a specially built flume. Under these ideal flume conditions 95 percent confidence intervals on the least-squares fit of data points are about ± 0.15 fps. Conditions on the model such as dirt, heat, and cold tend to decrease the value of this confidence interval somewhat but still it is probably less than 0.3 fps.

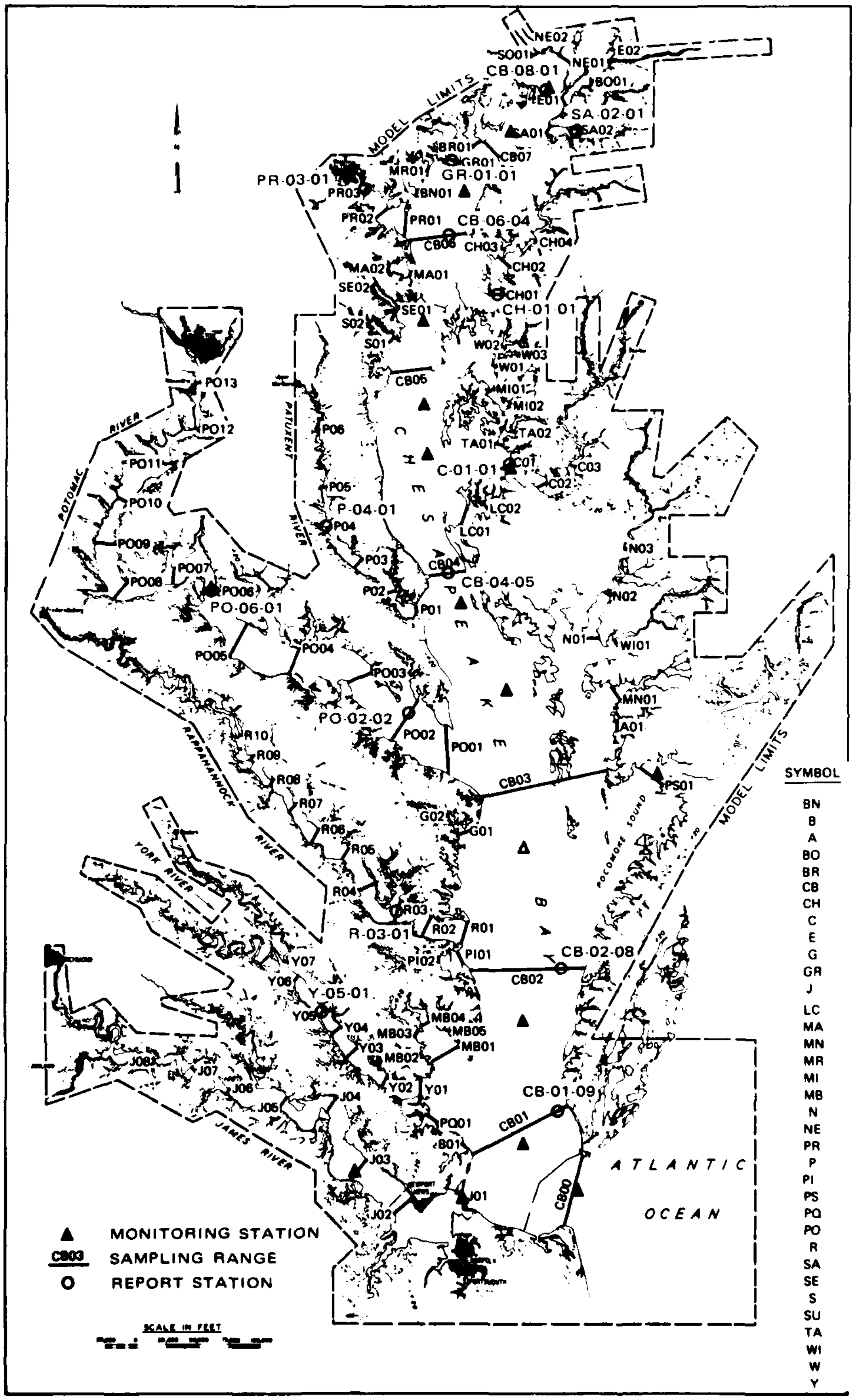
Source Salinity

53. Source salinity is defined as the salinity of supply water as it enters the headbay at the ocean. This definition was chosen to facilitate sampling and control of salinity. During varying freshwater discharges the mixing of fresh and salt water at the ocean causes discontinuous and variable salinities in the vicinity of the headbay. Sampling in this area can yield large changes in salinity over relatively short periods, especially during high freshwater discharge periods. The supply sump is a large and nearly homogeneous volume of water (analogous to the prototype ocean) that reacts slowly to a spiked hydrograph; thus, it can be measured less often and with greater confidence in a single set of measurements. Salinity samples were taken in the headbay, in the return sump, and in the supply sump once per hour throughout the entire study. Testing of the three areas together helps project trends

in the source salinity and thus large drops in source salinity can be prevented by adding brine to the return sump when it shows a decline. Source salinity was kept to within ±0.5 ppt of the desired value for most of both tests. Some discrepancies can be seen in the comparisons at the beginning of both tests. This was due in large part to inexperience in sump control for the LFIS. The Future Test was run before the Base Test and the very large hydrograph step changes caused drops in source salinity that were not properly anticipated. As the tests progressed, changes in the hydrograph became less pronounced and sump control could be anticipated more easily. It can be seen that the error band narrows as time passes, and during the Base Test sump control is well within the error band for the Future Test. Sump control in general was considered very good for both tests. Short-term deviations as seen in the beginning of the Future Test do not create perceptible discrepancies in the bay salinities. Test averages for both tests were within ±0.2 ppt of the desired 32.5 ppt and were within ±0.1 ppt of each other, making sump control comparable for the two LFIS tests.

Salinity Sampling

54. It was necessary during testing to monitor the distribution of salinity within the bay to ensure that general expected patterns were developing and that anomalies in the bay were explainable within the context of the test. In order to accomplish this task, a set of 19 stability monitoring stations was selected to give a general picture of the baywide salinity structure (Figure 13). Samples were obtained at the times of slack after flood periodically throughout each test. These salinity monitoring stations were not considered part of the LFIS testing program but were selected for compatibility with other studies for comparison. The salinity monitoring stations were used to determine when the model had reached the dynamic salinity equilibrium required for test initiation and were a real-time test monitoring aid. Samples were taken at slack after flood at each of the 19 salinity monitoring stations on every tide 3 and every tide 30 throughout the tests. The samples were



SYMBOL	RIVER
BN	BACK RIVER NORTH
B	BACK RIVER SOUTH
A	BIG ANNEMESSEX
BO	BOHEMIA
BR	BUSH
CB	CHESAPEAKE BAY
CH	CHESTER
C	CHOPTANK
E	ELK
G	GREAT WICOMICO
GR	GUN POWDER
J	JAMES RIVER
LC	LITTLE CHOPTANK
MA	MAGOTHY
MN	MANOKIN
MR	MIDDLE
MI	MILES
MB	MOBJACK BAY
N	NANTICOKE
NE	NORTH EAST
PR	PATAPSCO
P	PATUXENT
PI	PIANKATANK
PS	POCOMOKE SOUND
PQ	POQUOSON
PO	POTOMAC
R	RAPPAHANNOCK
SA	SASSAFRASS
SE	SEVERN
S	SOUTH
SU	SUSQUEHANNA
TA	TRED AVON
WI	WICOMICO
W	WYE
Y	YORK

Figure 13. Salinity sampling stations

analyzed immediately and hand-plotted to facilitate rapid analysis. No abnormalities in density structure were observed in either test and consequently confidence in their comparability is high.

55. Salinities in the bay were sampled at 206 individual stations at from one to five depths per station (Figure 13 and Table 3). A total of 550 samples were taken during each sampling period. The sampled tides were 1, 10, 28, and 48 for slack after flood which represent high-spring, neap, low-spring, and neap tides, respectively (Figure 11). In addition to slack after flood samples, slack after ebb samples were taken four times per year, once each season on tide 35. In all, 218,350 samples were scheduled for the Future Test and 244,200 were scheduled for the Base Test.

PART V: TEST RESULTS

Tides

56. Continuous records of tide levels were taken at 22 stations. Water-level detectors were placed at each of these 22 locations and their data were transmitted to the computer and stored.

57. Comparisons of Base and Future records of tides indicate no major tide discontinuities that would negatively affect the interpretation of the salinity data during the periods of concern in this report (Plates 23-26). No perceptible phase differences occurred between tests, and plane measurements due to varying inflows between tests were minute. A more detailed analysis of tide conditions in this study is possible; however, this is outside the scope of this report.

Current Velocities

58. Due to the limitations of the velocity meters, it was found during testing that many of the stations chosen could not be tested with confidence. Shallow depths and low velocities caused unrealistic or unreliable values to be discarded leaving only six stations (out of 16) with data to be compared. During other studies conducted in the model, velocity data were taken during constant tide and constant inflow conditions which presented the opportunity for multiple sampling of the desired conditions at each depth, increasing the confidence levels of the data by giving indications of repeatability. Multiple testing of a single depth in variable tide, variable hydrograph conditions is difficult. If a meter does not perform satisfactorily (i.e. is sticking or behaving abnormally) the velocity sample for that testing period is lost with no chance to repeat it later. Multiple depth testing presents unique problems in a variable tide, variable hydrograph situation. Three-depth testing, for example, requires that velocities be taken on three tides of equal height and equal inflow values. For the LFIS, samples were taken on tides 55, 1, and 3 which are nearly equal spring

tides, and on tides 44, 46, and 48 which are nearly equal neap tides (Figure 11). The procedure was to monitor one depth at tide 55 (or 44), change depths; monitor a second depth at tide 1 (or 46), change depths; and finally monitor the third depth at tide 3 (or 48).

59. Velocity measurements taken during the test point to differences between the Base and Future conditions; but confidence in the absolute values is low, due to the required testing procedure. Velocity plots for select stations are presented in Plates 27-32. In general, no evidence exists to attribute differences in velocity to changes in freshwater inflow.

Salinity Distribution

60. The LFIS produced a salinity data set that consisted of 1/2 million data values from 206 salinity stations, each having from one to five sampling depths. To accomplish a detailed analysis of each of the stations would be prohibitive in both time and costs. For the purposes of this report, 32 stations that were representative of a large range of possible prototype conditions were chosen and a detailed analysis was performed on each. Of these 32 stations, 15 were selected to be displayed within this report. Data listings at selected times are given in Table 4, time-histories are given in Plates 33-62, and selected salinity profiles are given in Plates 63-110.

61. Response of the model to the prescribed boundary conditions resulted in salinity values at each station that varied as a function of hydrographic season, tide amplitude, and relative closeness of a particular boundary. During model testing, a particular salinity station could show a higher sensitivity to any of the above influences; however, the response is certainly influenced by all of them concurrently. To remove any of the influences could invoke an entirely different salinity response at the station. It is the summation of these influences that in a unique interactive way controls the distribution of salinity throughout the estuary.

62. Strong seasonal variations in salinity were noticed at all

stations during the test. Freshening of the station profiles was noticed during periods of high freshwater discharge, and conversely, saltier profiles were noticed during drought conditions. In addition, it was quite common for individual stations to show increased stratification during high freshwater discharge conditions. This response becomes more pronounced as one travels upstream in the rivers and in the main bay toward the freshwater boundary. Response of the model to these seasonal freshwater changes is shown dramatically in the Potomac River. Sta PO-06-01 and PO-02-02 show strong stratification changes between high and low freshwater inflow conditions (Plates 63-78).

63. During the high-flow periods, sta PO-06-01 exhibits a pronounced salinity difference between surface and bottom but becomes nearly homogeneous in the following low-flow period, with a net increase in salt over the profile. Seasonal variations in stratification are noticed in both historical and modal years. Sta PO-02-02 shows similar changes in stratification. Sta PO-02-02 (at the mouth of the river), however, shows this seasonal response to a lesser degree. The distance from the freshwater boundary and the closeness to the local saltwater boundary at the mouth of the Potomac are thought to be responsible for this phenomenon.

64. Another general tendency noticed in the model salinities was the salinity response to tide amplitude or the "neap-spring" effect. The effect is shown quite clearly in the salinity time-history plots as sawtoothed variations in the salinity record (Plates 33-62). Successively sampled tides 1, 10, 28, and 48 define the high-spring, neap, low-spring, and neap salinity variations. The "neap-spring" effect was noticed in most stations throughout the model in varying degrees. Good examples of strong neap-spring variations are sta CB-01-09 and PO-06-01 (Plates 35, 36, 53, and 54). Sta CB-01-09 is an example of a station that shows the variations at all depths in the profile. This station also illustrates the response of higher amplitude tides causing a mixing of the profile with successive lower amplitude tides serving to increase the stratification. Figure 14 covers lunar days 1932-2040 at sta CB-01-09 showing the salinity changes with tide amplitude. This

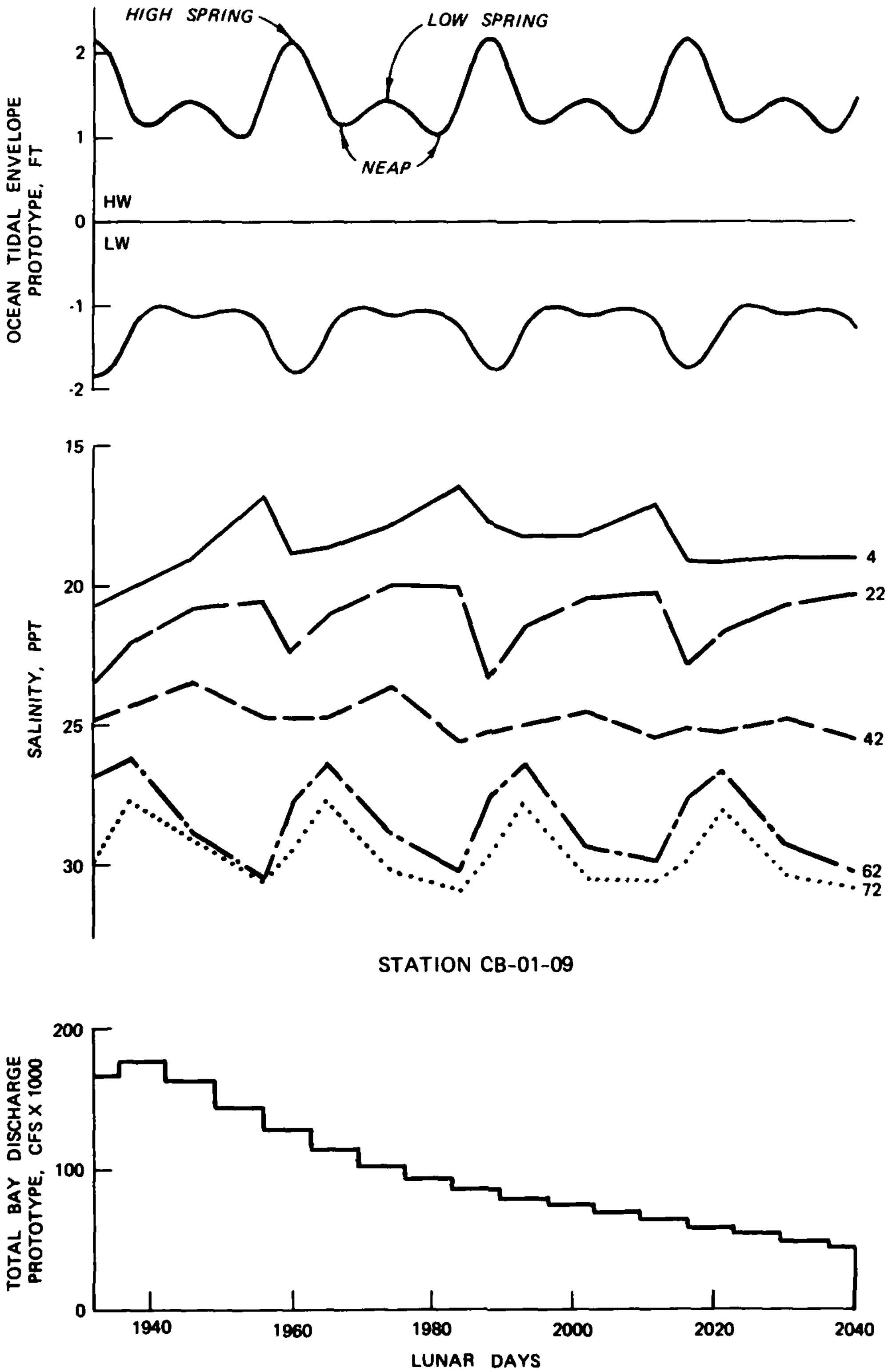


Figure 14. Lunar days 1932-2040 at sta CB-01-09 showing salinity changes with tide amplitude

trend was noticed in many stations throughout the bay.

65. At some stations, neap-spring variations were observed at isolated depths in the profile. Sta PO-06-01 shows strong variations in the surface and bottom depths but very little at the middepth. Some stations show strongest variations in the surface depths (CB-06-04, Plates 41 and 42) while others largely in the bottom depths (CB-02-08, Plates 37 and 38).

66. The magnitude of neap-spring variations at stations which show this response appear to be discharge-dependent. This occurs due to change in the vertical salinity gradient that accompanies varying discharges. Vertical salinity gradients tend to be greater during periods of high flow thereby causing a greater tendency to show neap-spring changes in stratification. This response is noticeable in the time-history plots for sta CB-01-09 and PO-06-01 (Plates 36 and 53). The increase of variations with increase in discharge is apparent at most stations showing neap-spring variations. There are occasions, however, where the magnitude of neap-spring variations are inversely proportional to discharge. Sta GR-01-01 (Plate 47) is an example of this response. During high-flow periods, the station is not located in a highly stratified portion of the estuary; but as discharge decreases, the intrusion of salts brings a more stratified condition to the station. A detailed examination of neap-spring interaction is not within the scope of this report but should be pursued.

67. The closeness and strength of a particular boundary to a sampling station also have an effect on the salinity response of that station. This closeness manifests itself differently in the data, depending on the type of boundary condition. Upper bay tributary stations respond to high-flow conditions by feeling the influence of the dominant flows of the Susquehanna River. During low flows, stations in the tributaries respond more directly to the discharge of their individual river. An example of this phenomenon occurs in the Chester and Choptank Rivers. Both rivers are very similar hydrodynamically in that they are relatively wide, shallow Eastern Shore rivers with low freshwater discharges and similar tidal characteristics. Both rivers respond to

hydrographic changes in a similar fashion during low-flow periods but quite differently during high-flow periods. The Chester River shows a marked increase in stratification that is not noticed in the Choptank River. Sta CH-01-01 (Chester) and C-01-01 (Choptank) illustrate this point (Plates 33, 34, 45, and 46). The dissimilarity is caused by the relative closeness of the Chester River to the dominant high flows of the Susquehanna River. The Choptank River is far enough from the Susquehanna so that the Susquehanna's influence is not as great as it is in the Chester. This dominance of the Susquehanna flows during high-flow conditions affects a large number of upper bay stations. This same phenomenon presents itself in other portions of the bay, especially where the unequal discharges of branched rivers are close to individual sampling stations.

68. The closeness of the saltwater boundary to the salinity station is also important in the salinity response of a station. Lower bay stations in proximity to the model ocean reflect a certain amount of the forced response of a constant salinity boundary condition. This is illustrated at sta CB-01-09 near the mouth of the bay (Plates 35 and 36) in that aside from neap-spring variations, bottom salinities remain fairly constant throughout hydrographic changes in the bay. Constant salinity in the bottom layers at sta CB-01-09 reflect the boundary control in the model ocean which was maintained at a constant salinity. Other stations in the lower bay, although not depicted within this report, exhibit the same type of salinity response based on their closeness to the saltwater boundary condition.

Consumptive Losses

69. An analysis of the salinity data for the 32 representative stations indicates that throughout the model, the projected "consumptive losses" for the year 2020 have a quantifiable although variable impact on the salinity structure of the bay. The impact of the consumptive losses varied from station to station, depending on the closeness of local freshwater or salinity boundary conditions and on their individual

hydrodynamic characteristics. Within a single station, the effects of consumptive losses quite often varied with the hydrographic season, high-flow periods showing less salinity differences between tests than low-flow periods. Salinity profiles presented in Plates 63-110 display the vertical structures during both the Base and Future Tests of 15 select stations. These 15 stations represent a large range of conditions that may be observed in the prototype. However, before predictions of how the bay will respond to consumptive losses can be made, the data from the remaining representative stations should be reviewed. Such a review was conducted, although the other data are not presented herein.

70. In general, the vertical structure at each station is similar in the Base and Future conditions. This should be expected if the boundary control of both tests was repeated and the degree of inflow suppression between tests was as small as designed. There are, however, subtle differences in structure between stations. To get a proper picture of how consumptive losses affect the bay, it is perhaps best to discuss groupings of stations with similar hydrodynamic properties.

71. Salinity profiles for sta CB-01-09, CB-02-08, and CB-04-05 are presented in Plates 95-110. These stations are representative of stations in the lower to mid-bay regions. All three stations show structural similarity between tests with the effects of consumptive losses felt equally throughout the water column. This is thought to be a typical response of main bay stations due to the remoteness of the stations from the inflow points and the buffering capacity of the large main bay volume. Sta CB-01-09 behaves somewhat differently than sta CB-04-05 and CB-02-08 because of its closeness to the ocean salinity boundary. This is manifested by bottom salinities for both tests being nearly equal, reflecting the constant nature of the ocean source salinity. Salinity differences for these three stations do not show strong seasonal changes and average approximately 2 ppt saltier throughout the water column in the Future Test.

72. Salinity profiles for sta R-03-01 and Y-05-01 are shown in Plates 79-94; these stations are from the Rappahannock and York Rivers, respectively, and are examples of higher discharge western shore rivers.

Both stations show similar responses to the effect of consumptive losses, on the order of 1 to 2 ppt saltier in the Future Test. Sta Y-05-01 shows a stronger structural difference between high and low flows; however, sta R-03-01 might have shown a similar response if a 4-ft-depth sample was taken.

73. Salinity profiles for sta PO-06-01, PO-02-02, and P-04-01 are presented in Plates 63-78. Sta PO-02-02 and PO-06-01 are from the Potomac River which is a very high discharge river. Both stations show complex structural changes from high to low flows which are consistent in both the Base and Future Tests. The effect of consumptive losses on these Potomac River stations is somewhat more complex than that observed in other stations; however, on the average these appear to be approximately 2 ppt saltier in the historical portion of the Future Test. The differences between the Base and Future Tests decreased somewhat in the modal years.

74. Sta P-04-01 is from the Patuxent River which is a case of a river having a higher freshwater discharge due to wastewater loading in the Future condition. Even though the freshwater gain is very small (Plate 12), its effect is noticed in the data (particularly at the surface). There is generally a slightly greater salinity gradient in the upper 20 ft of the water column during the Future Test with some crossover of salinity values making the Future Test fresher at the surface. Lower depths do not show a freshening in the Future Test because the relative strength of the main bay salinity boundary condition is increased in the Future Test.

75. Sta CH-01-01 and C-01-01 are from the Chester and Choptank Rivers, respectively, and their salinity profiles are given in Plates 63-79. Both stations react similarly to the Potomac stations in that their surface salinities are similar between tests during high-flow conditions but diverge during low-flow conditions. Differences in consumptive loss response between high- and low-flow conditions could be due to localized mixing differences. Both rivers, however, are large in volume when compared with their discharges so their response to consumptive losses is more indicative of boundary condition changes at

their mouths than their own freshwater boundary. This is particularly true in the Chester due to the closeness of the Susquehanna River and its dominant flows.

76. Sta SA-02-01, GR-01-01, and PR-03-01 are from the Sassafras, Gunpowder, and Patapsco Rivers; all are considered low-discharge rivers and are located in the upper bay. The three stations from these rivers exhibit the classical response to changes in flow conditions (Plates 79-94). During periods of high discharge the water column is more stratified with smaller differences between Base and Future Tests. Periods of low discharge provide a water column that is better mixed with larger Base to Future differences. The Susquehanna River is the dominant freshwater input for these stations, so Base to Future differences in salinity can be associated largely with consumptive losses of the Susquehanna River. On the average, consumptive losses resulted in a 1 to 2 ppt saltier Future condition.

77. Sta CB-06-04 and CB-08-01 are examples of upper main bay stations that strongly show the influence of the Susquehanna River (Plates 95-110). Sta CB-08-01 is entirely fresh during high-flow conditions and well mixed during low-flow conditions. Consumptive losses resulted in a 2 to 3 ppt saltier profile in the historical portion of the Future Test. During the modal years, the Base to Future differences average 1 to 2 ppt saltier in the Future Test.

78. Sta CB-06-04 has substantial data losses; however, existing data indicate that this station is highly sensitive to the flows of the Susquehanna. This station shows one of the sharpest salinity gradients (during high-discharge periods) observed of the 32 stations studied and it was noticed in both the Base and Future Tests. Data coverage during the historical period shown is spotty, but the modal years indicate that on the average consumptive losses resulted in a 2 ppt saltier Future condition.

Dynamic Normalcy

79. Another objective of the LFIS is to determine the amount of

time required for the bay to return to a state of dynamic salinity equilibrium for an average year, after several years of drought conditions. The opportunity to observe this phenomenon presents itself in the series of identical modal hydrographs implemented following WY 1966 in the Base Test or its equivalent in the Future Test. In the Base Test, this modal hydrograph was repeated four times giving ample opportunity to compare values from successive modal years to determine when salinity values from this portion of the test were repeated.

80. Expectations of repeatability must be tempered somewhat because of the incompatibility of lunar-day-based sampling times and solar weekly stepped hydrographs. A water year contains 52 solar weeks or approximately 351.7 lunar days; this is 12.56, 28-lunar-day tide cycles. Thus, if the first and second modal years are compared, comparable tide samples occur about two weeks apart and consequently on different hydrograph steps. The closest approximations to identically sampled modal hydrographs available in this test are comparisons between modal year 1 and modal year 3 and between modal year 2 and modal year 4. In this instance, analogous samples are only 3.5 days apart and may occur on the same hydrograph step but also may occur on a different hydrograph step. In the case of the LFIS, the first slack-after-flood sample was taken on tide 48, lunar day 1424, which was on hydrograph step 2 in the first modal year. Seven hundred lunar days later on lunar day 2124 the comparable tide occurred on hydrograph step 1 of the third modal year. Thus, when we compare the first and third modal years we are comparing samples taken on different hydrograph steps with different freshwater discharge conditions for tide 48. The same is true of the next sampling on tide 1. Lunar day 1428 occurs on hydrograph step 3 in the first modal year while the comparable tide occurs on hydrograph step 2 of the third modal year. Tide 10 sampling occurs on hydrograph step 3 of both modal years and tide 28 sampling occurs on hydrograph step 4 of both modal years. Thus begins a cycle of two samplings--one hydrograph step removed and two samplings on the same hydrograph step but removed by 3.5 days.

81. Even with the discrepancies indicated by moving the inflow

changes with respect to the tide, there is a point when comparing the first and third and second and fourth modal years where the differences in salinity become minimal and fall, for the most part, within an arbitrary error band which has been set at 1 ppt. Plates 111-115 show time-history plots of differences obtained by subtracting the consecutive salinity values of modal years 1 and 2 from the corresponding values in modal years 3 and 4. A relatively short time was required to bring difference values within the expected range. The differences that occurred when comparing the last portion of modal year 2 to 4 was due to a boundary control problem.

Data Set

82. One of the more important aspects of the LFIS was the creation of a large data set. Only a small portion of the available data was used for analysis in this report. The complete data set consists of more than 3 million data points including 1/2 million values of salinity, spanning four water years of record, four projected drought years, and seven modal hydrographs. This data set is available to the public for use in any way compatible with its limitations. The model staff can provide help in interpreting the data with regard to test procedures and measurement accuracy.

General

83. In drawing conclusions about the LFIS from the data presented in this report, it is necessary to maintain a realistic perspective of the model and its capabilities and, conversely, its limitations. The Chesapeake Bay model is the largest facility of its kind in the world, the sampling systems are largely automated and rapid, and the possibilities for collecting large data bases of nearly any kind of tidal or freshwater discharge condition seem limitless. The LFIS is an example of the great potential of the model, providing a large data base of more than 3 million measurements including tides, current velocities, and

salinity. The study took nearly a year to complete from the initial preparation to the last day of testing. It is, however, the great size of the data base that is the limiting factor in analyzing the results. Quantitative or statistical overview of the study and comparison of tests provide problems even for a computer with large central memory capacity and rapid processing capabilities. It is for this reason that the approach of this report is limited in scope.

84. As an initial probe into this large data base, 32 stations were selected as representative of the main bay and its tributaries; and these data were handled as though they were a complete test. It is apparent that generally the data base must be approached in this manner, providing a series of reports dealing with various aspects of the drought conditions and consumptive losses. The Base Test alone can provide much information about the reponse of the bay during low-discharge conditions and its rebound capabilities.

85. Several other factors must be considered in the analysis of the data. One of these is the presence of the deepened Baltimore Harbor and approach channels. These channels were deepened to 50 ft below mean sea level for this test because the deeper channel is more likely for future conditions. This presents difficulties in comparing the results with prototype data because differences in salinity intrusion were noted as the result of deepening these channels, particularly in the vicinity of the port of Baltimore, during the Baltimore Harbor and Channels Deepening Study (Granat and Gulbrandsen 1982*).

86. While much time and effort were expended in providing correct discharge values for the entire bay, positioning of the inflows in the model is such that the true distribution of lateral inflows and in some cases of smaller tributary inflows is not similar to the prototype. Many inflows represent the combined freshwater discharges of numerous small freshwater inflows and neglect their distribution within the subsystems. The Nanticoke, York, Choptank, and Elk Rivers are primary examples of unmodeled inflows at forks in the river, and the absence of freshwater

* Granat and Gulbrandsen, op cit.

discharge from other main bay tributaries such as the Elizabeth, Back (Virginia), Piankatank, Saint Mary's, South, Magothy, Back (Maryland), Bush, and Sassafras and the combination of these flows in the discharges of other major tributaries probably cause salinity distributions within these areas that are not strictly comparable to the prototype. It is not felt that combination of these inflows results in distortion of salinities in the main bay. At the same time, providing the precisely located STP inflows in detail probably has less significance to the results than their inclusion implies.

87. Ocean salinity near the mouth of the bay in the prototype varies greatly from season to season and is more reflective of the freshwater discharge than the model's source salinity. In the case of the LFIS, variations in source salinity during the beginning of Future Test probably more realistically reflect prototype conditions than the more constantly maintained Base Test source salinity.

88. In spite of these difficulties, however, much information can be gleaned from the salinity measurements, although some reservations must be kept in mind. Salinity structure within profiles is of great importance in interpreting the data. It can be seen from the profile plots that structure may change considerably from high- to low-flow conditions, but remains remarkably consistent between Base and Future Tests. In general, it might be said that average salinities through a profile maintained a 1 to 3 ppt difference. This, however, is a dangerous generalization when it is the stations that do manifest structural differences, which may be most important. It is the interaction of a large number of variables including salinity that determines the impact of drought conditions on organisms. With this in mind it is clear that statistical representations of a salinity distribution must be carefully analyzed before they can be used to imply ecological impacts. Each concern must be considered individually in combination with other variables before any conclusions can be drawn in this regard.

89. Hydrodynamically, the distribution of salinity does say something about the relationship of freshwater inflow to salt intrusion and even further to mixing characteristics within the bay. Generally,

as one might expect, a greater amount of freshwater in the bay causes a decrease in the amount of saltwater in the bay, simply conservation of mass, given equivalent water levels. Seasonal variations in inflow seem to dominate the structural changes at all stations; however, subtle changes in structure do occur with different tide ranges in a few stations. Time or vertically averaged salinity distributions are again not considered relevant if biweekly neap-spring variations are to be dealt with.

90. Finally, it should be noted that the frequency of sampling is such that each sample is reflective of a different inflow condition as well as a different tide condition. This further reinforces the importance of recognizing the uniqueness of each sample.

PART VI: CONCLUSIONS

Consumptive Losses

91. This test has shown that consumptive losses in general cause a saltier bay. The magnitude and structural variations in salinity response as a result of consumptive losses are dependent on the specific hydrodynamic characteristics of a sampling area and its proximity to freshwater or saltwater boundary conditions. On the average, however, the 32 stations analyzed responded to consumptive losses with a 1 to 3 ppt saltier Future condition. Model sensitivity and repeatability in terms of salinity are thought to be approximately 1 ppt, but the results reported herein are consistent enough to suggest that the 1 to 3 ppt difference is valid with little need to establish confidence limits. In general, the vertical salinity structure was not affected by the consumptive losses.

92. Quantifying the effects of consumptive losses will inevitably lead to predictions on the expected ecological condition of Chesapeake Bay. Prior to making such predictions based on this report, it is important to note that the analysis addressed data from only 32 test stations. Before the ecological ramifications of consumptive losses are predicted from this data set, all 206 stations should be considered.

Dynamic Normalcy

93. Return to dynamic normalcy is apparently related to the discharge characteristics of the tributary in question. High-discharge rivers seem to fall within the normal range within 100 lunar days. Sta PO-02-02 is an example of a high-discharge river (Potomac) which has a very rapid response time (Plate 114). Sta R-03-01, on the Rappahannock, shows a somewhat slower response time and is an example of a moderate discharge river (Plate 115). The Choptank River is an example of a low-discharge river on the eastern shore and sta C-01-01 takes approximately 150 lunar days to achieve dynamic normalcy (Plate 111). The main bay

also seems to respond quickly to an increase in inflow. Sta CB-01-09 (Plate 112) reaches its normal level well within the 100 lunar days required by the higher discharge rivers. Lag times associated with distances from inflow points are overshadowed by the influence of the relative magnitude of the river's discharge.

94. It is difficult to draw conclusions about dynamic normalcy because the low-flow period immediately preceding the first modal year is somewhat mitigated by a small but significant spike in inflow (see Plate 1, week 208). This may have accelerated the model's return to average flow conditions. Of major importance, however, is the indication that inflow perturbations to the system have only transient effects on Chesapeake Bay and that within several months, depending upon location, the bay can rebound from high saline conditions. In addition, these comparisons give an indication of the high degree of repeatability that can be achieved in the model which is an important consideration when comparing tests with small changes in boundary conditions.

Table 1

Sewage Treatment Plants

	Name	Latitude	Longitude
A	Back River STP	39°17'33"	76°28'55"
B	Patapsco River STP	39°12'03"	76°31'58"
C	Sparrows Point STP	39°13'37"	76°29'30"
D	Arlington, VA STP	38°50'30"	77°03'25"
E	Blue Plains STP	38°49'00"	77°01'42"
F	Alexandria STP	38°47'44"	77°03'38"
G	Piscataway STP	38°42'12"	77°03'05"
H	Lower Potomac STP	38°41'50"	77°12'00"
I	Mattawoman STP	38°36'53"	77°07'52"
J	James River STP	37°04'35"	76°32'20"
K	Boat Harbor WTP	36°37'30"	76°24'48"
L	Lamberts Point Outfall	36°52'58"	76°24'00"
M	Hampton Roads Little Creek STP	36°56'35"	76°10'17"

Table 2

Lead-in Condition

Average Yearly Freshwater Inflow

Inflow	Tributary	Prototype Discharge, cfs	Percent of Total
1	Nansemond River	700	1.0
2	Chickahominy River	300	0.4
3	Appomattox River	1,000	1.4
4	James River	7,500	10.4
5	York River	2,750	3.8
6	Rappahannock River	2,940	4.1
7	Wicomico (Potomac) River	426	0.6
8	Occoquan Creek	2,452	3.4
9	Anacostia River	602	0.8
10	Potomac River	7,964	11.0
11	Patuxent River	911	1.3
12	Severn River	239	0.3
13	Patapsco River	634	0.9
14	Gunpowder River	830	1.1
15	Susquehanna River	38,500	53.2
16	Bohemia River	400	0.6
17	Chester River	519	0.7
18	Wye River	196	0.3
19	Choptank River	845	1.2
20	Nanticoke River	1,675	2.3
21	Pocomoke River	1,031	1.4
	Total	72,414	

Table 3

Salinity Stations

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Big Annemessex R.		
A-01-01	19	4, 17
A-02-01	7	4
Back R., Virginia		
B-01-01	16	2, 15
Back R., Maryland		
BN-01-01	7	4
BN-02-01	6	3
Bohemia R.		
BO-01-01	9	4
Bush R.		
BR-01-01	12	10
Choptank, R.		
C-00-01	18	2, 16
C-00-02	54	2, 27, 52
C-01-01	70	4, 12, 22, 42, 62
C-02-01	31	4, 12, 27
C-03-01	14	4, 11
C-04-01	29	2, 15, 27
Chesapeake Bay		
CB-00-01	59	4, 12, 22, 32
02	68	4, 22, 32, 52, 68
03	42	4, 22, 32
05	20	4, 12, 17
07	21	4, 12, 18
08	49	4, 22, 42
09	17	3, 7, 14
CB-01-01	16	4, 16
03	27	4, 14, 27
05	52	4, 22, 50
07	28	4, 12, 27
09	77	4, 22, 42, 62, 72
CB-02-02	26	4, 12, 25
04	36	4, 22, 32
06	42	4, 22, 42
08	59	4, 32, 57
10	28	4, 12, 27

(Continued)

(Sheet 1 of 7)

Table 3 (Continued)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Chesapeake Bay (Continued)		
CB-03-01	38	4, 22, 38
03	68	4, 22, 32, 52, 68
04	71	4, 22, 32, 52, 62
06	42	4, 22, 37
CB-03-08	27	4, 12, 18
10	61	4, 12, 32, 42, 57
11	21	4, 15
CB-04-01	36	4, 22, 32
03	65	4, 12, 32, 52, 62
04	103	4, 22, 52, 72, 92
05	102	4, 22, 52, 72, 97
06	26	4, 12, 22
07	18	4, 16
CB-05-02	37	4, 22, 32
04	65	2, 12, 32, 52, 62
05	109	4, 32, 52, 82, 109
06	25	4, 12, 20
CB-06-01A	55	2, 28, 53
01	22	2, 20
03	33	2, 12, 32
04	37	2, 22, 37
05	20	2, 19
CB-07-01	15	5, 10
03	34	2, 12, 29
04	24	2, 12, 22
05	46	2, 22, 38
CB-08-01	21	4, 11, 20
02	6	3
03	9	5
04	16	4, 15
Chesapeake & Delaware Canal		
CD-01-01	39	4, 20, 38
Chester R.		
CH-00-01	22	2, 11, 20
CH-00-02	28	2, 14, 26
CH-01-01	55	4, 32, 52

(Continued)

Table 3 (Continued)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Chester R. (Continued)		
CH-02-01	25	4, 12, 24
CH-02-02	30	4, 14, 26
CH-03-01	18	4, 11
CH-04-01	49	4, 22, 44
CH-05-01	11	2, 9
Elk R.		
E-01-01	20	4, 12, 18
E-02-01	10	4, 8
Eastern Bay		
EB-01-01	58	2, 29, 56
EB-01-02	27	2, 14, 25
Fishing Bay		
FB-01-01	21	2, 11, 19
Great Wicomica R.		
G-01-01	19	4, 14, 17
Gunpowder R.		
GR-01-01	22	2, 12, 22
Hooper Island		
H-01-01	10	2, 8
James R.		
J-01-01	16	1, 13
02	52	1, 23, 43
03	81	1, 13, 23, 43, 72
J-02-01	14	1, 13
02	26	1, 13, 23
03	50	1, 23, 43
J-03-01	20	1, 13, 20
02	21	1, 13, 20
J-04-01	19	1, 19
02	20	1, 13, 20
J-05-01	23	0, 13, 20
02	41	0, 20, 39
J-06-01	25	3, 13, 23
J-07-01	30	3, 13, 28
J-08-01	30	5, 15, 25
J-09-01	31	2, 16, 29

(Continued)

(Sheet 3 of 7)

Table 3 (Continued)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
James R. (Continued)		
J-10-01	26	2, 13, 24
Little Choptank R.		
LC-01-01	17	4, 12
LC-02-01	22	4, 12, 21
Magothy R.		
MA-01-01	21	4, 12, 18
MA-02-01	18	4, 15
Mobjack Bay		
MB-01-01	16	0, 13
02	20	0, 20
03	20	0, 20
MB-03-01	25	0, 13, 20
MB-04-01	24	13
Miles R.		
MI-01-01	38	4, 22, 32
MI-02-01	12	4, 12
Manokin R.		
MN-01-01	9	4
MN-02-01	9	5
Middle R.		
MR-01-01	9	2
Nanticoke R.		
N-01-01	27	4, 12, 24
N-02-01	14	4, 12
N-03-01	14	4, 12
North East R.		
NE-01-01	13	4, 11
NE-02-01	9	4
Patuxent R.		
P-01-01	44	4, 22, 40
02	56	4, 32, 52
P-02-01	27	4, 12, 22
02	80	4, 22, 42, 52, 62
P-03-01	28	4, 12, 22
P-04-01	38	4, 22, 32
P-05-01	13	4, 12

(Continued)

Table 3 (Continued)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Patuxent R. (Continued)		
P-06-01	27	4, 12, 22
Potomac R.		
PO-01-01	28	2, 12, 22
02	40	2, 22, 37
03	42	2, 22, 40
04	54	2, 32, 50
05	32	2, 12, 31
PO-02-01	34	2, 22, 30
02	60	2, 12, 32, 42, 60
03	34	2, 22, 30
PO-03-01	62	2, 12, 32, 42, 57
02	39	2, 22, 36
PO-04-01	30	2, 12, 22
02	42	2, 22, 42
PO-05-01	16	2, 12
02	20	2, 19
03	26	2, 10, 19
PO-06-01	64	2, 12, 22, 42, 62
PO-07-01	20	2, 12
02	24	2, 12, 21
PO-08-01	11	1, 6
02	20	4, 18
PO-09-01	13	2, 13
02	24	2, 11, 21
PO-10-01	30	2, 12, 28
02	30	2, 12, 22
PO-11-01	33	2, 12, 32
PO-12-02	61	2, 12, 32, 42, 52
PO-13-02	26	2, 12, 25
PO-14-02	22	4, 12, 22
PO-15-01	47	4, 24, 47
PO-16-01	9	4
Piankatank R.		
PI-01-01	23	4, 12, 20
Poquoson R.		
PQ-01-01	16	3, 10

(Continued)

Table 3 (Continued)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Patapsco R.		
PR-01-01	16	2, 14
02	17	2, 14
03	54	2, 32, 53
PR-02-01	17	2, 14
02	53	2, 22, 52
PR-03-01	53	2, 22, 52
02	23	3, 12, 22
Pocomoke Sound		
PS-01-01	8	4
PS-02-01	14	2, 12
Rappahannock, R.		
R-01-01	30	1, 13, 30
02	36	1, 20, 33
R-03-01	60	1, 13, 26, 46, 59
02	24	1, 13, 20
R-05-01	27	1, 13, 26
R-06-01	19	1, 19
R-07-01	19	1, 18
R-08-01	24	1, 13, 20
R-09-01	16	1, 16
R-10-01	26	1, 16, 26
R-11-01	47	2, 24, 45
R-12-01	42	2, 21, 40
R-13-01	31	2, 16, 29
South R.		
S-01-01	17	4, 12
S-02-01	18	4, 17
Sassafras R.		
SA-01-01	15	4, 14
SA-02-01	38	4, 22, 37
Severn R.		
SE-01-01	20	4, 18
SE-02-01	29	4, 12, 21
02	24	2, 12, 22
Susquehanna R.		
SU-01-01	16	0, 13
02	28	11, 19, 26

(Continued)

Table 3 (Concluded)

Station	Model Depth (Proto Ft)	Sampling Depths (Proto Ft)
Tred Avon R.		
TA-01-01	26	4, 12, 23
TA-02-01	20	4, 14, 19
Tangier Sound		
TS-01-01	2	2
02	41	2, 21, 39
03	5	3
Wye R.		
W-01-01	57	4, 32, 51
W-02-01	23	4, 12, 21
W-03-01	15	4, 12
Wicomico R.		
WI-01-01	13	4, 11
York R.		
Y-01-01	37	3, 23, 33
02	56	5, 25, 54
Y-02-01	72	4, 14, 34, 54, 69
Y-03-01	18	9
02	30	3, 13, 30
Y-04-01	17	3, 11
02	37	12, 18, 25
Y-05-01	30	4, 14, 26
Y-06-01	28	4, 14, 24
Y-07-01	18	4, 17
02	15	4, 14

(Sheet 7 of 7)

Table 4

Salinity Data

SALINITY (PPT)
STATION: C-01-01

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	4	15.5	15.7	0.2	686	4	16.8	17.4	0.6
	12	16.6	18.3	1.7		12	16.9	17.6	0.7
	22	16.7	18.2	1.5		22	17.1	17.8	0.7
	42	16.8	18.3	1.5		42	17.2	18.1	0.9
	62	16.6	18.3	1.7		62	17.3	*****	*****
510	4	11.1	10.9	-0.2	696	4	16.9	17.2	0.3
	12	16.3	17.4	1.1		12	17.0	17.4	0.4
	22	16.4	18.0	1.6		22	17.7	*****	*****
	42	*****	18.1	*****		42	17.8	18.2	0.4
	62	16.3	18.2	1.9		62	17.8	18.8	1.0
520	4	7.8	7.7	-0.1	700	4	16.2	18.0	1.8
	12	11.2	13.1	1.9		12	17.3	18.2	0.9
	22	13.9	16.3	2.4		22	17.1	18.2	1.1
	42	15.4	17.7	2.3		42	17.5	*****	*****
	62	15.4	17.9	2.5		62	17.8	18.5	0.7
532	4	8.0	8.9	0.9	705	4	17.6	17.4	-0.2
	12	10.9	12.6	1.7		12	17.6	*****	*****
	22	13.5	14.6	1.1		22	17.9	18.2	0.3
	42	15.0	16.3	1.3		42	17.9	*****	*****
	62	15.1	16.7	1.6		62	17.9	18.5	0.6
892	4	*****	15.7	*****	1350	4	15.1	16.8	1.7
	12	*****	18.5	*****		12	16.2	17.6	1.4
	22	*****	18.5	*****		22	16.7	17.7	1.0
	42	*****	18.6	*****		42	16.7	17.9	1.2
	62	*****	18.7	*****		62	16.8	17.9	1.1
896	4	*****	16.6	*****	1360	4	14.6	16.8	2.2
	12	*****	17.9	*****		12	15.3	17.9	2.6
	22	*****	18.1	*****		22	17.1	18.3	1.2
	42	*****	18.4	*****		42	17.2	18.5	1.3
	62	*****	18.2	*****		62	17.5	18.6	1.1
901	4	*****	15.9	*****	1372	4	16.0	17.7	1.7
	12	*****	17.8	*****		12	16.9	18.1	1.2
	22	*****	17.6	*****		22	17.0	18.2	1.2
	42	*****	17.8	*****		42	17.2	18.5	1.3
	62	*****	17.6	*****		62	17.5	18.8	1.3
910	4	*****	15.9	*****	1377	4	16.2	17.3	1.1
	12	*****	17.3	*****		12	17.1	17.9	0.8
	22	*****	17.3	*****		22	17.1	18.3	1.2
	42	*****	17.6	*****		42	17.3	18.7	1.4
	62	*****	17.4	*****		62	17.5	18.8	1.3
1582	4	12.1	11.6	0.5	1741	4	15.0	15.4	0.4
	12	14.6	15.5	0.9		12	15.3	16.2	0.9
	22	14.6	14.8	0.2		22	15.5	16.4	0.9
	42	14.7	15.6	0.9		42	15.6	16.8	1.2
	62	14.7	14.9	0.2		62	15.8	16.7	0.9
1592	4	*****	10.1	*****	1750	4	14.9	16.3	1.4
	12	13.8	14.1	0.3		12	15.7	16.8	1.1
	22	14.4	15.1	0.7		22	16.0	17.0	1.0
	42	14.6	15.5	0.9		42	16.1	17.1	1.0
	62	14.6	15.4	0.8		62	16.2	17.4	1.2
1596	4	10.8	10.7	-0.1	1760	4	14.7	*****	*****
	12	13.1	13.5	0.4		12	16.2	*****	*****
	22	13.7	14.5	0.8		22	16.3	*****	*****
	42	14.1	15.2	1.1		42	16.5	*****	*****
	62	14.1	15.1	1.0		62	16.7	*****	*****
1601	4	10.1	10.3	0.2	1764	4	15.9	17.0	1.1
	12	12.4	13.3	0.9		12	16.3	17.4	1.1
	22	13.0	14.1	1.1		22	16.3	17.2	0.9
	42	13.4	14.4	1.0		42	16.6	17.9	1.3
	62	13.5	14.4	0.9		62	16.5	17.8	1.3
2292	4	9.4	8.6	-0.8	2450	4	14.7	16.2	1.5
	12	13.4	12.8	-0.6		12	15.3	16.6	1.3
	22	13.8	15.0	1.2		22	14.9	16.7	1.8
	42	14.0	15.4	1.4		42	15.8	16.9	1.1
	62	14.0	15.5	1.5		62	15.9	17.1	1.2
2296	4	9.9	9.6	-0.3	2460	4	13.7	16.2	2.5
	12	13.1	13.0	-0.1		12	15.8	17.1	1.3
	22	13.2	14.3	1.1		22	15.9	17.1	1.2
	42	13.5	14.2	0.7		42	16.2	17.4	1.2
	62	13.5	14.8	1.3		62	16.2	17.4	1.2
2301	4	9.2	8.9	-0.3	2464	4	15.0	16.6	1.6
	12	12.5	13.0	0.5		12	15.9	17.0	1.1
	22	12.6	13.9	1.3		22	15.9	17.1	1.2
	42	12.9	13.6	0.7		42	16.2	17.3	1.1
	62	12.9	14.0	1.1		62	16.2	17.3	1.1
2310	4	8.9	8.5	-0.4	2469	4	15.4	16.6	1.2
	12	12.1	12.6	0.5		12	15.9	17.2	1.3
	22	12.3	13.6	1.3		22	16.0	17.3	1.3
	42	12.5	14.0	1.5		42	16.4	17.5	1.1
	62	12.6	13.7	1.1		62	16.4	17.5	1.1

(Continued)

Note: 24.84 hr/lunar day--lunar day 1 is start of test.

(Sheet 1 of 15)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-01-09

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	4	23.0	24.8	1.8	686	4	22.7	25.3	2.6
	22	24.1	26.0	1.9		22	23.7	26.0	2.3
	42	25.7	27.7	2.0		42	26.5	28.7	2.2
	62	27.0	29.4	2.4		62	28.0	29.6	1.6
	72	27.4	****	****		72	****	30.3	****
518	4	21.4	22.9	1.5	696	4	22.8	24.9	2.1
	22	22.1	23.9	1.8		22	24.9	26.6	1.7
	42	23.2	25.3	2.1		42	27.7	29.9	2.2
	62	25.3	29.2	3.9		62	29.6	30.5	0.9
	72	28.7	****	****		72	29.6	31.0	1.4
528	4	18.9	21.4	2.5	700	4	24.5	25.8	1.3
	22	21.7	23.4	1.7		22	26.8	28.7	1.9
	42	24.8	27.8	3.0		42	28.2	29.9	1.7
	62	29.6	31.1	1.5		62	28.9	30.3	1.4
	72	30.2	****	****		72	30.2	30.7	0.5
532	4	20.2	21.9	1.7	705	4	23.7	25.8	2.1
	22	23.3	25.7	2.4		22	24.7	27.2	2.5
	42	25.3	27.3	2.0		42	****	29.6	****
	62	26.6	****	****		62	28.5	30.3	1.8
	72	29.3	****	****		72	29.0	30.5	1.5
892	4	21.6	****	****	1358	4	22.9	24.0	1.1
	22	23.5	****	****		22	24.1	25.0	0.9
	42	25.7	****	****		42	26.7	27.4	0.7
	62	29.7	****	****		62	27.8	28.4	0.6
	72	30.4	****	****		72	30.0	29.1	-0.9
896	4	22.9	****	****	1368	4	21.5	23.5	2.0
	22	25.8	****	****		22	24.5	25.2	0.7
	42	26.5	****	****		42	27.4	28.5	1.1
	62	27.5	****	****		62	29.9	29.4	-0.5
	72	29.3	****	****		72	30.4	29.9	-0.5
901	4	22.2	22.3	0.1	1372	4	23.6	25.1	1.5
	22	23.9	23.3	-0.6		22	26.5	27.7	1.2
	42	25.7	25.7	0.0		42	27.5	28.7	1.2
	62	27.3	27.8	0.5		62	28.5	29.2	0.7
	72	27.6	28.3	0.7		72	28.5	29.4	0.9
910	4	21.3	21.6	0.3	1377	4	23.3	24.7	1.4
	22	22.9	23.1	0.2		22	25.2	26.3	1.1
	42	24.8	25.4	0.6		42	27.2	28.6	1.4
	62	27.4	28.3	0.9		62	28.1	29.3	1.2
	72	30.0	30.0	0.0		72	28.3	29.3	1.0
1582	4	20.3	21.9	1.6	1741	4	22.0	22.5	0.5
	22	21.8	23.4	1.6		22	23.9	25.3	1.4
	42	24.2	25.8	1.6		42	26.1	28.3	2.2
	62	28.8	29.5	0.7		62	27.4	28.8	1.4
	72	30.1	30.7	0.6		72	28.0	29.1	1.1
1592	4	18.0	****	****	1750	4	22.3	22.6	0.5
	22	21.2	****	****		22	23.3	24.8	1.5
	42	25.0	26.2	1.2		42	26.1	27.8	1.7
	62	30.6	****	****		62	27.8	29.0	1.2
	72	30.9	****	****		72	30.0	30.6	0.6
1596	4	19.5	****	****	1760	4	21.7	****	****
	22	22.6	****	****		22	24.2	25.7	1.5
	42	25.2	26.1	0.9		42	26.5	29.5	3.0
	62	27.5	****	****		62	27.7	30.5	2.8
	72	29.7	****	****		72	31.3	31.0	-0.3
1601	4	19.3	20.5	1.2	1764	4	23.5	22.1	-1.4
	22	21.6	23.2	1.6		22	26.5	27.3	0.8
	42	25.0	****	****		42	28.1	****	****
	62	26.3	27.1	0.8		62	28.9	****	****
	72	27.7	28.3	0.6		72	29.2	29.5	0.3
2292	4	18.7	****	****	2450	4	22.4	23.3	0.9
	22	21.3	24.9	3.6		22	23.5	****	****
	42	24.9	27.8	2.9		42	26.1	28.3	2.2
	62	30.6	30.7	0.1		62	27.7	29.5	1.8
	72	30.9	31.2	0.3		72	30.2	30.7	0.5
2296	4	19.9	****	****	2460	4	21.6	22.9	1.3
	22	23.2	25.5	2.3		22	23.7	****	****
	42	24.5	27.2	2.7		42	27.4	29.4	2.0
	62	27.6	28.9	1.3		62	30.5	30.9	0.4
	72	29.8	30.0	0.2		72	30.7	31.2	0.5
2301	4	19.3	****	****	2464	4	23.2	24.5	1.3
	22	21.5	22.9	1.4		22	26.2	28.0	1.8
	42	24.2	26.5	2.3		42	27.4	29.4	2.0
	62	26.0	27.8	1.8		62	28.1	29.9	1.8
	72	27.7	28.2	0.5		72	29.4	30.0	0.6
2310	4	18.3	****	****	2469	4	22.9	24.2	1.3
	22	20.0	21.0	1.3		22	25.2	26.5	1.3
	42	23.2	26.0	2.8		42	26.0	28.1	2.1
	62	29.2	29.9	0.7		62	27.8	29.7	1.9
	72	30.4	31.0	0.6		72	28.1	30.0	1.9

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-02-08

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	4	19.4	21.2	1.8	686	4	19.8	21.8	2.0
	32	24.8	27.4	2.6		32	25.4	27.9	2.5
	57	26.9	29.8	2.9		57	27.3	29.2	1.9
510	4	18.3	19.5	1.2	696	4	20.2	22.1	1.9
	32	23.9	25.9	2.0		32	26.6	27.9	1.3
	57	26.8	29.8	3.0		57	29.3	30.5	1.2
520	4	16.0	17.3	1.3	700	4	21.3	22.4	1.1
	32	23.4	25.6	2.2		32	26.1	28.2	2.1
	57	28.8	31.9	3.1		57	28.9	30.4	1.5
532	4	15.4	16.8	1.4	705	4	21.2	22.7	1.5
	32	23.9	27.2	3.3		32	26.6	28.3	1.7
	57	28.6	32.0	3.4		57	27.7	29.3	1.6
892	4	19.3	20.8	1.5	1350	4	19.8	21.0	1.2
	32	25.1	25.6	0.5		32	26.2	26.9	0.7
	57	30.0	29.7	-0.3		57	28.3	28.3	0.0
896	4	19.7	20.4	0.7	1360	4	20.1	20.7	0.6
	32	25.2	25.8	0.6		32	26.6	*****	*****
	57	29.5	29.5	0.0		57	29.6	25.2	-4.4
901	4	19.3	20.3	1.0	1372	4	20.5	21.6	1.1
	32	25.9	26.3	0.4		32	26.3	27.8	1.5
	57	28.2	28.3	0.1		57	29.5	29.9	0.4
910	4	18.2	19.3	1.1	1377	4	20.8	22.2	1.4
	32	24.9	25.8	0.9		32	26.3	27.6	1.3
	57	28.5	28.6	0.1		57	28.2	28.7	0.5
1582	4	17.7	18.8	1.1	1741	4	19.7	20.2	0.5
	32	24.4	26.8	2.4		32	26.6	28.1	1.5
	57	28.6	29.3	0.7		57	28.4	29.7	1.3
1592	4	17.8	17.7	-0.1	1750	4	19.8	20.4	0.6
	32	23.1	25.7	2.6		32	25.9	27.0	1.1
	57	29.7	31.3	1.6		57	28.6	30.0	1.4
1596	4	16.6	18.1	1.5	1760	4	19.1	20.4	1.3
	32	19.4	26.3	6.9		32	25.6	28.4	2.8
	57	*****	30.9	*****		57	30.1	30.8	0.7
1601	4	16.2	17.5	1.3	1764	4	20.0	22.2	2.2
	32	25.0	26.9	1.9		32	25.9	27.6	1.7
	57	28.5	29.5	1.0		57	29.2	30.4	1.2
2292	4	16.0	17.4	1.4	2450	4	19.2	19.7	0.5
	32	24.2	25.1	0.9		32	25.5	27.0	1.5
	57	30.3	30.2	-0.1		57	28.4	28.9	0.5
2296	4	16.1	17.2	1.1	2460	4	18.8	19.9	1.1
	32	23.6	26.5	2.9		32	25.8	27.4	1.6
	57	29.7	30.3	0.6		57	29.7	30.2	0.5
2301	4	15.7	16.8	1.1	2464	4	19.7	20.7	1.0
	32	24.2	26.5	2.3		32	25.9	27.5	1.6
	57	28.2	29.1	0.9		57	29.2	29.9	0.7
2310	4	14.5	16.0	1.5	2469	4	19.8	21.1	1.3
	32	23.5	26.1	2.6		32	26.2	27.6	1.4
	57	26.3	30.5	4.2		57	27.6	28.8	1.2

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-04-05

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	4	16.0	*****	*****	686	4	17.9	19.0	1.1
	22	17.0	*****	*****		22	18.9	21.0	2.1
	52	20.0	*****	*****		52	20.4	22.7	2.3
	72	20.7	*****	*****		72	20.8	24.4	3.6
	97	21.9	23.2	1.3		97	22.9	26.0	3.1
510	4	10.2	*****	*****	696	4	17.9	*****	*****
	22	16.1	*****	*****		22	19.3	*****	*****
	52	19.2	*****	*****		52	*****	*****	*****
	72	20.2	*****	*****		72	22.0	24.3	2.3
	97	21.8	23.2	1.4		97	*****	25.0	*****
520	4	7.1	*****	*****	700	4	*****	20.6	*****
	22	13.0	*****	*****		22	19.5	21.5	2.0
	52	19.0	*****	*****		52	20.0	22.7	2.7
	72	20.2	*****	*****		72	21.9	23.9	2.0
	97	20.9	22.6	1.7		97	22.6	25.6	3.0
532	4	7.6	*****	*****	705	4	*****	20.6	*****
	22	14.7	*****	*****		22	*****	21.5	*****
	52	*****	*****	*****		52	21.0	22.8	1.8
	72	19.2	*****	*****		72	21.0	23.8	2.8
	97	20.5	22.6	2.1		97	*****	25.5	*****
892	4	15.2	16.7	1.5	1350	4	16.9	18.4	1.5
	22	18.2	19.2	1.0		22	19.0	19.9	0.9
	52	20.4	21.2	0.8		52	20.8	21.3	0.5
	72	22.0	22.6	0.6		72	22.4	23.4	1.0
	97	22.7	23.8	1.1		97	23.7	25.4	1.7
896	4	14.9	16.6	1.7	1360	4	16.8	15.9	-0.9
	22	18.1	19.3	1.2		22	19.1	19.6	0.5
	52	20.8	21.8	1.0		52	20.9	*****	*****
	72	21.3	22.1	0.8		72	23.0	23.4	0.4
	97	22.3	23.4	1.1		97	23.9	25.3	1.4
901	4	14.2	15.7	1.5	1372	4	17.8	19.7	1.9
	22	17.4	18.7	1.3		22	19.2	20.7	1.5
	52	20.0	20.6	0.6		52	21.0	22.3	1.3
	72	21.6	22.2	0.6		72	22.7	23.8	1.1
	97	22.5	23.3	0.8		97	23.8	25.1	1.3
910	4	12.5	15.1	2.6	1377	4	17.6	19.5	1.9
	22	17.7	18.5	0.8		22	19.4	20.8	1.4
	52	19.6	20.5	0.9		52	21.0	22.4	1.4
	72	21.3	21.8	0.5		72	22.7	23.6	0.9
	97	22.3	23.1	0.8		97	23.7	24.9	1.2
1582	4	11.1	12.2	1.[illegible]	1741	4	*****	17.1	*****
	22	15.8	17.4	1.6		22	*****	19.1	*****
	52	19.4	21.5	2.1		52	*****	21.7	*****
	72	20.9	23.1	2.2		72	*****	23.7	*****
	97	21.8	24.4	2.6		97	*****	25.3	*****
1592	4	10.7	11.4	[illegible]	1750	4	*****	18.0	*****
	22	14.2	16.0	1.[illegible]		22	*****	19.8	*****
	52	19.0	21.[illegible]	2.[illegible]		52	*****	21.9	*****
	72	20.4	2[illegible].0	2.6		72	*****	23.3	*****
	97	2[illegible].3	24.0	2.7		97	*****	25.4	*****
1596	4	9.9	10.5	0.6	1760	4	16.4	*****	*****
	22	14.5	16.4	1.[illegible]		22	17.8	19.3	1.5
	52	18.2	20.9	2.7		52	19.8	21.9	2.1
	72	20.1	22.9	2.8		72	21.6	23.7	2.1
	97	21.2	24.1	2.9		97	22.5	*****	*****
1601	4	9.6	10.2	0.6	1764	4	16.9	*****	*****
	22	13.7	15.4	1.7		22	18.2	*****	*****
	52	18.8	21.1	2.3		52	19.8	21.9	2.1
	72	20.2	22.7	2.5		72	21.4	23.1	1.7
	97	21.3	23.8	2.5		97	22.7	*****	*****
2292	4	10.4	10.2	-0.2	2450	4	16.0	17.5	1.5
	22	14.1	15.5	1.4		22	18.0	19.3	1.3
	52	18.9	20.8	1.9		52	19.6	21.7	2.1
	72	21.3	20.9	-0.4		72	21.4	23.7	2.3
	97	21.4	23.7	2.3		97	22.7	25.3	2.6
2296	4	9.7	10.4	0.7	2460	4	15.8	17.5	1.7
	22	15.0	15.3	0.3		22	18.2	19.6	1.4
	52	18.4	20.6	2.2		52	20.2	22.1	1.9
	72	20.1	22.6	2.5		72	22.1	24.4	2.3
	97	21.9	23.9	2.0		97	22.9	25.6	2.7
2301	4	10.0	9.9	-0.1	2464	4	17.1	18.0	0.9
	22	13.9	15.1	1.2		22	18.4	19.5	1.1
	52	18.7	20.9	2.2		52	20.1	21.9	1.8
	72	20.4	22.4	2.0		72	21.9	23.7	1.8
	97	21.4	23.6	2.2		97	23.8	25.4	2.4
2310	4	9.4	*****	*****	2469	4	15.7	17.1	1.4
	22	14.0	15.4	1.4		22	18.6	19.7	1.1
	52	16.4	20.4	4.0		52	20.8	22.1	1.3
	72	19.6	20.6	1.0		72	21.9	24.0	2.1
	97	20.8	22.4	1.6		97	23.0	25.4	2.4

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-06-04

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	2	3.7	3.4	-0.3	686	2	10.7	16.4	5.7
	22	12.1	13.4	1.3		22	16.7	19.7	3.0
	37	17.3	****	****		37	****	20.0	****
510	2	0.5	0.6	0.1	696	2	****	16.1	****
	22	11.3	16.1	4.8		22	****	19.3	****
	37	15.1	****	****		37	****	20.7	****
520	2	0.7	0.8	0.1	700	2	****	17.0	****
	22	9.8	14.1	4.3		22	****	20.0	****
	37	13.0	****	****		37	****	20.5	****
532	2	1.6	2.2	0.6	705	2	****	17.1	****
	22	9.4	17.8	8.4		22	****	19.0	****
	37	12.2	****	****		37	****	20.6	****
892	2	3.5	****	****	1350	2	13.2	14.0	0.8
	22	14.2	****	****		22	16.6	17.7	1.1
	37	18.2	****	****		37	18.3	20.3	2.0
896	2	4.3	****	****	1360	2	11.9	14.1	2.2
	22	15.7	****	****		22	16.7	18.2	1.5
	37	17.7	****	****		37	18.5	20.2	1.7
901	2	****	****	****	1372	2	14.2	15.4	1.2
	22	15.7	****	****		22	17.9	19.2	1.3
	37	17.5	****	****		37	18.5	20.2	1.7
910	2	****	4.3	****	1377	2	14.1	15.6	1.5
	22	****	18.9	****		22	17.4	18.7	1.3
	37	****	19.5	****		37	18.5	20.3	1.8
1582	2	1.6	1.5	-0.1	1741	2	10.7	10.6	-0.1
	22	16.0	19.1	3.1		22	15.3	16.1	0.8
	37	17.5	20.4	2.9		37	17.0	****	****
1592	2	1.3	1.2	-0.1	1750	2	10.0	****	****
	22	9.4	13.0	3.6		22	15.8	****	****
	37	16.7	20.0	3.3		37	17.4	****	****
1596	2	1.4	****	****	1760	2	9.0	****	****
	22	12.0	****	****		22	15.2	****	****
	37	16.7	****	****		37	17.7	****	****
1601	2	1.2	1.4	0.2	1764	2	11.7	****	****
	22	12.2	15.8	3.6		22	16.0	****	****
	37	16.5	19.6	3.1		37	17.3	****	****
2292	2	1.0	0.8	-0.2	2450	2	10.4	12.0	1.6
	22	11.9	10.6	-1.3		22	15.8	18.2	2.4
	37	17.7	18.1	0.4		37	17.5	19.5	2.0
2296	2	2.0	1.4	-0.6	2460	2	9.1	10.2	1.1
	22	16.1	13.0	-3.1		22	15.0	17.5	2.5
	37	17.5	16.8	-0.7		37	17.8	19.7	1.9
2301	2	1.4	1.2	-0.2	2464	2	11.8	11.9	0.1
	22	14.2	14.8	0.6		22	16.7	18.4	1.7
	37	17.1	15.4	-1.7		37	17.6	19.9	2.3
2310	2	1.4	1.1	-0.3	2469	2	11.2	****	****
	22	14.5	15.0	0.5		22	16.1	17.6	1.5
	37	16.7	17.7	1.0		37	17.3	[illegible]	2.4

(Continued)

(Sheet 5 of 15)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-08-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	4	0.1	0.3	0.2	686	4	4.0	6.7	2.7
	11	0.1	0.3	0.2		11	4.4	7.4	3.0
	20	0.1	0.3	0.2		20	4.7	7.6	2.9
510	4	0.1	0.3	0.2	696	4	3.8	7.3	3.5
	11	*****	0.3	*****		11	4.5	7.9	3.4
	20	0.1	0.3	0.2		20	5.6	8.3	2.7
520	4	0.1	0.3	0.2	700	4	5.1	8.7	3.6
	11	0.1	0.3	0.2		11	5.5	8.9	3.4
	20	*****	0.3	*****		20	5.9	9.1	3.2
532	4	0.1	0.3	0.2	705	4	5.1	8.3	3.2
	11	0.1	0.3	0.2		11	5.3	8.9	3.6
	20	0.1	0.3	0.2		20	5.6	9.0	3.4
892	4	*****	*****	*****	1350	4	3.2	4.0	0.8
	11	*****	*****	*****		11	3.5	5.0	1.5
	20	*****	*****	*****		20	3.6	5.5	1.9
896	4	*****	*****	*****	1360	4	3.0	4.6	1.6
	11	*****	*****	*****		11	3.5	5.0	2.3
	20	*****	*****	*****		20	3.9	5.0	1.9
901	4	*****	0.3	*****	1372	4	4.6	6.5	1.9
	11	*****	0.3	*****		11	4.6	6.0	2.2
	20	*****	0.3	*****		20	4.0	7.1	2.3
910	4	*****	0.3	*****	1377	4	3.7	5.7	2.0
	11	*****	0.3	*****		11	4.0	6.3	2.3
	20	*****	0.3	*****		20	4.1	6.4	2.3
1582	4	0.1	0.1	0.0	1741	4	0.4	0.5	0.1
	11	*****	*****	*****		11	0.4	0.9	0.5
	20	0.1	0.1	0.0		20	0.5	0.9	0.4
1592	4	*****	*****	*****	1750	4	0.6	0.7	0.1
	11	*****	*****	*****		11	0.9	1.4	0.5
	20	*****	*****	*****		20	1.2	2.2	1.0
1596	4	*****	*****	*****	1760	4	0.2	1.3	1.1
	11	*****	*****	*****		11	0.4	1.3	0.9
	20	*****	*****	*****		20	0.0	3.4	2.6
1601	4	0.1	*****	*****	1764	4	1.0	2.7	1.7
	11	*****	*****	*****		11	1.1	2.7	1.6
	20	*****	*****	*****		20	1.4	2.9	1.5
2292	4	0.2	0.1	-0.1	2450	4	0.7	0.7	0.0
	11	0.2	0.2	0.0		11	0.7	1.1	0.4
	20	0.2	0.1	-0.1		20	0.0	*****	*****
2296	4	0.2	0.2	0.0	2460	4	0.6	1.1	0.5
	11	0.3	0.2	-0.1		11	0.8	1.4	0.6
	20	0.2	0.1	-0.1		20	0.9	2.4	1.5
2301	4	0.3	0.1	-0.2	2464	4	1.3	1.2	-0.1
	11	0.2	0.2	0.0		11	1.5	2.0	0.5
	20	0.3	0.1	-0.2		20	1.6	2.5	0.9
2310	4	0.2	0.1	-0.1	2469	4	0.8	1.1	0.3
	11	0.2	0.1	-0.1		11	0.9	1.4	0.5
	20	0.3	0.2	-0.1		20	0.9	1.5	0.6

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: CB-01-01

LUNAR DAY	DEPTH	HIGH FLOW BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	LOW FLOW BASE	FUTURE	FUTURE-BASE
509	4	9.7	8.7	-1.0	505	4	13.0	15.5	2.5
	32	17.7	19.4	1.7		32	15.9	17.8	1.9
	52	17.0	19.0	2.0		52	14.7	18.3	3.6
510	4	2.5	2.4	-0.1	696	4	-----	15.6	-----
	32	17.6	19.4	1.8		32	15.7	18.1	2.4
	52	17.0	19.0	2.0		52	-----	18.1	-----
520	4	1.3	1.8	0.5	700	4	-----	15.8	-----
	32	17.6	19.4	1.8		32	-----	17.5	-----
	52	17.8	19.7	1.9		52	-----	-----	-----
532	4	2.2	2.4	0.2	705	4	-----	15.8	-----
	32	17.4	19.3	1.9		32	-----	18.1	-----
	52	17.5	19.6	2.1		52	-----	-----	-----
892	4	9.4	-----	-----	1358	4	11.9	13.8	1.9
	32	18.2	20.1	1.9		32	16.4	18.0	1.6
	52	18.1	20.5	2.4		52	16.7	19.0	2.3
896	4	9.5	9.9	0.4	1368	4	11.1	11.7	0.6
	32	17.8	-----	-----		32	16.2	17.0	0.8
	52	18.1	20.5	2.4		52	16.7	17.2	0.5
901	4	8.9	9.2	0.3	1372	4	12.9	15.7	2.8
	32	17.8	20.2	2.4		32	16.8	18.5	1.7
	52	18.0	20.3	2.3		52	16.9	18.7	1.8
910	4	-----	8.6	-----	1377	4	12.8	15.5	2.7
	32	-----	20.2	-----		32	16.7	18.4	1.7
	52	-----	20.3	-----		52	16.9	18.5	1.6
1502	4	5.9	6.9	1.0	1741	4	10.1	11.8	1.7
	32	16.9	19.1	2.2		32	15.1	17.0	1.9
	52	17.0	19.3	2.3		52	15.3	17.1	1.8
1592	4	4.3	4.9	0.6	1750	4	11.0	-----	-----
	32	16.0	17.8	1.8		32	15.3	-----	-----
	52	17.1	19.1	2.0		52	15.7	-----	-----
1596	4	3.9	4.9	1.0	1760	4	10.9	-----	-----
	32	16.9	18.5	1.6		32	15.5	-----	-----
	52	16.9	19.0	2.1		52	16.2	-----	-----
1601	4	3.4	4.9	1.5	1764	4	12.3	-----	-----
	32	16.7	18.6	1.9		32	15.7	-----	-----
	52	17.0	18.9	1.9		52	16.1	-----	-----
2292	4	3.4	4.4	1.0	2450	4	11.5	13.1	1.6
	32	16.1	18.0	1.9		32	14.4	16.5	2.1
	52	16.2	18.2	2.0		52	15.2	16.8	1.6
2296	4	3.4	3.8	0.4	2460	4	9.7	12.4	2.7
	32	15.9	17.9	2.0		32	14.8	16.8	2.0
	52	15.9	18.0	2.1		52	14.7	17.3	2.6
2301	4	3.4	3.5	0.1	2464	4	11.9	13.2	1.3
	32	15.8	17.9	2.1		32	15.4	16.6	1.2
	52	15.8	17.9	2.1		52	15.6	17.0	1.4
2310	4	3.3	3.4	0.1	2469	4	11.5	12.7	1.2
	32	15.7	17.7	2.0		32	15.6	16.9	1.3
	52	15.8	17.8	2.0		52	15.6	17.3	1.7

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: GR-01-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	2	3.2	4.2	1.0	686	2	9.1	11.9	2.8
	12	8.3	9.6	1.3		12	11.6	14.4	2.8
	22	8.8	9.8	1.0		22	12.0	14.6	2.6
510	2	0.5	1.4	0.9	696	2	9.1	11.5	2.4
	12	4.1	4.6	0.5		12	10.4	14.8	4.4
	22	7.1	8.3	1.2		22	12.7	15.2	2.5
520	2	0.1	0.5	0.4	700	2	10.5	12.4	1.9
	12	2.0	2.5	0.5		12	12.2	15.2	3.0
	22	5.7	6.7	1.0		22	12.6	15.5	2.9
532	2	0.4	1.2	0.8	705	2	11.4	13.3	1.9
	12	0.7	1.3	0.6		12	12.5	15.4	2.9
	22	4.9	6.3	1.4		22	13.0	15.5	2.5
892	2	1.1	1.5	0.4	1358	2	8.4	8.3	-0.1
	12	6.8	9.0	2.2		12	11.5	11.7	0.2
	22	9.3	11.3	2.0		22	12.1	12.6	0.5
896	2	1.6	1.6	0.0	1368	2	8.4	9.7	1.3
	12	5.2	7.0	1.8		12	12.0	11.7	-0.3
	22	8.5	10.9	2.4		22	12.6	*****	*****
901	2	1.6	2.3	0.7	1372	2	10.6	9.7	-0.9
	12	4.8	6.6	1.8		12	12.6	12.3	-0.3
	22	8.1	10.0	1.9		22	13.0	13.3	0.3
910	2	1.0	1.6	0.6	1377	2	10.7	11.1	0.4
	12	4.0	5.7	1.7		12	12.8	12.2	-0.6
	22	8.2	9.3	1.1		22	13.8	13.8	0.0
1582	2	0.7	0.6	-0.1	1741	2	6.5	6.1	-0.4
	12	2.0	2.1	0.1		12	9.6	10.0	0.4
	22	4.5	7.0	2.5		22	9.9	10.5	0.6
1592	2	0.2	0.7	0.5	1750	2	5.9	6.2	0.3
	12	1.0	1.0	0.0		12	9.7	10.4	0.7
	22	3.5	6.0	2.5		22	10.3	11.3	1.0
1596	2	0.3	0.7	0.4	1760	2	5.5	*****	*****
	12	0.5	0.7	0.2		12	10.7	9.7	-1.0
	22	2.4	5.3	2.9		22	11.4	12.0	0.6
1601	2	0.4	0.6	0.2	1764	2	7.6	*****	*****
	12	0.5	0.7	0.2		12	10.5	11.1	0.6
	22	0.7	4.7	4.0		22	11.1	12.4	1.3
2292	2	0.5	0.3	-0.2	2458	2	5.4	6.0	0.6
	12	3.0	1.7	-1.3		12	9.0	9.9	0.9
	22	4.4	6.9	2.5		22	9.8	10.7	0.9
2296	2	0.7	0.4	-0.3	2460	2	5.1	5.6	0.5
	12	2.6	1.1	-1.5		12	9.9	11.2	1.3
	22	4.2	6.2	2.0		22	10.7	12.0	1.3
2301	2	0.6	0.5	-0.1	2464	2	7.1	7.4	0.3
	12	1.3	0.9	-0.4		12	10.2	11.1	0.9
	22	3.2	6.0	2.8		22	10.6	11.6	1.0
2310	2	0.5	0.5	0.0	2469	2	7.4	7.8	0.4
	12	0.9	0.7	-0.2		12	10.4	11.2	0.8
	22	2.6	5.2	2.6		22	10.6	11.6	1.0

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: P-04-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	4	8.3	9.2	0.9	686	4	15.9	16.0	0.1
	22	17.8	19.1	1.3		22	17.2	19.0	1.8
	32	18.3	19.7	1.4		32	17.5	19.0	1.5
510	4	7.1	6.6	-0.5	696	4	15.6	16.0	0.4
	22	17.8	19.1	1.3		22	17.0	19.5	2.5
	32	18.4	19.4	1.0		32	17.9	19.6	1.7
520	4	5.3	5.0	-0.3	700	4	16.4	16.7	0.3
	22	16.7	18.5	1.8		22	17.8	19.2	1.4
	32	17.6	18.7	1.1		32	17.9	19.4	1.5
532	4	4.9	5.1	0.2	705	4	16.8	16.3	-0.5
	22	15.6	17.6	2.0		22	17.9	19.2	1.3
	32	17.3	18.4	1.1		32	18.1	19.4	1.3
892	4	9.5	9.9	0.4	1350	4	14.2	14.5	0.3
	22	18.2	20.2	2.0		22	17.6	18.2	0.6
	32	18.9	20.9	2.0		32	17.6	18.3	0.7
896	4	6.4	10.2	3.8	1360	4	14.5	13.7	-0.8
	22	18.1	19.5	1.4		22	18.2	18.9	0.7
	32	18.2	20.0	1.8		32	18.3	19.1	0.8
901	4	7.9	11.2	3.3	1372	4	15.4	14.4	-1.0
	22	17.7	19.0	1.3		22	18.1	18.9	0.8
	32	17.8	19.4	1.6		32	18.3	18.9	0.6
910	4	10.5	13.3	2.8	1377	4	15.3	15.2	-0.1
	22	17.4	18.8	1.4		22	18.2	19.1	0.9
	32	17.8	19.4	1.6		32	18.4	19.2	0.8
1582	4	5.8	7.7	1.9	1741	4	11.1	12.2	1.1
	22	13.7	17.6	3.9		22	15.9	17.7	1.8
	32	17.4	17.5	0.1		32	16.1	17.5	1.4
1592	4	4.5	4.8	0.3	1750	4	11.3	14.8	3.5
	22	14.6	17.5	2.9		22	16.2	18.2	2.0
	32	15.8	17.9	2.1		32	16.4	18.5	2.1
1596	4	5.4	5.8	0.4	1760	4	11.7	14.9	3.2
	22	14.2	16.8	2.6		22	15.8	19.0	3.2
	32	14.9	17.1	2.2		32	17.3	19.1	1.8
1601	4	5.4	5.2	-0.2	1764	4	11.1	15.0	3.9
	22	14.0	16.4	2.4		22	16.1	18.9	2.8
	32	14.7	17.2	2.5		32	17.0	18.6	1.6
2292	4	6.2	4.2	-2.0	2450	4	11.5	11.6	0.1
	22	16.1	18.0	1.9		22	16.3	18.0	1.7
	32	16.4	18.3	1.9		32	16.4	18.1	1.7
2296	4	5.6	6.6	1.0	2460	4	11.0	10.6	-0.4
	22	15.0	16.7	1.7		22	16.6	16.6	0.0
	32	15.7	17.7	2.0		32	16.9	17.2	0.3
2301	4	5.7	5.8	0.1	2464	4	10.5	12.5	2.0
	22	14.3	16.3	2.0		22	16.8	18.0	1.2
	32	15.4	17.4	2.0		32	15.9	18.3	1.1
2310	4	5.2	5.9	0.7	2469	4	12.6	12.0	-0.6
	22	14.9	16.4	1.5		22	16.9	18.2	1.3
	32	15.7	17.8	2.1		32	17.1	18.4	1.3

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: PO-02-02

		High Flow					Low Flow		
Lunar Day	Depth	Base	Future	Future-Base	Lunar Day	Depth	Base	Future	Future-Base
509	2	11.9	10.1	-1.8	606	2	17.1	16.6	-0.5
	12	*****	*****	*****		12	*****	*****	*****
	32	18.8	20.2	1.4		32	18.9	20.4	1.5
	42	20.6	21.5	0.9		42	20.2	21.4	1.2
	60	20.8	22.6	1.8		60	21.5	22.8	1.3
510	2	7.6	7.0	-0.6	696	2	*****	16.7	*****
	12	*****	*****	*****		12	*****	*****	*****
	32	18.3	19.7	1.4		32	*****	20.4	*****
	42	20.4	20.6	0.2		42	20.1	21.1	1.0
	60	20.5	22.4	1.9		60	21.8	23.0	1.2
520	2	6.8	5.9	-0.9	700	2	*****	17.5	*****
	12	*****	*****	*****		12	*****	*****	*****
	32	17.6	19.0	1.4		32	*****	20.7	*****
	42	19.4	20.4	1.0		42	20.0	21.5	1.5
	60	20.0	22.6	2.6		60	21.7	23.1	1.4
532	2	7.6	6.9	-0.7	705	2	*****	*****	*****
	12	*****	*****	*****		12	*****	*****	*****
	32	16.2	18.3	2.1		32	*****	*****	*****
	42	19.0	20.1	1.1		42	20.5	22.2	1.7
	60	19.8	22.2	2.4		60	21.0	*****	*****
892	2	8.3	8.4	0.1	1350	2	16.2	16.0	-0.2
	12	*****	17.0	*****		12	18.2	*****	*****
	32	18.8	20.3	1.5		32	19.0	20.2	1.2
	42	20.3	21.0	0.7		42	20.4	20.5	0.1
	60	22.2	23.1	0.9		60	21.9	22.5	0.6
896	2	7.8	6.9	-0.9	1360	2	16.3	16.7	0.4
	12	16.0	*****	*****		12	18.6	*****	*****
	32	18.5	20.0	1.5		32	19.2	18.1	-1.1
	42	19.7	20.7	1.0		42	20.5	18.6	-1.9
	60	21.8	22.7	0.9		60	22.3	21.7	-0.6
901	2	8.8	7.9	-0.9	1372	2	16.6	17.1	0.5
	12	*****	*****	*****		12	18.7	*****	*****
	32	18.4	19.8	1.4		32	19.5	21.0	1.5
	42	19.7	20.6	0.9		42	20.7	21.7	1.0
	60	21.4	22.1	0.7		60	22.2	23.4	1.2
910	2	*****	9.1	*****	1377	2	17.0	17.0	0.0
	12	15.5	*****	*****		12	18.8	*****	*****
	32	17.9	19.4	1.5		32	19.8	21.2	1.4
	42	19.3	20.5	1.2		42	20.8	22.0	1.2
	60	21.2	22.3	1.1		60	21.9	22.7	0.8
1582	2	9.0	9.9	0.9	1741	2	13.7	13.0	-0.7
	12	15.1	16.6	1.5		12	16.8	17.6	0.8
	32	17.7	19.4	1.7		32	18.2	19.3	1.1
	42	19.4	20.6	1.2		42	19.6	20.5	0.9
	60	20.8	22.8	2.0		60	20.7	22.2	1.5
1592	2	6.9	8.9	2.0	1750	2	14.1	*****	*****
	12	14.3	*****	*****		12	17.5	18.2	0.7
	32	17.7	18.8	1.1		32	18.3	20.0	1.7
	42	19.7	20.4	0.7		42	19.9	20.8	0.9
	60	21.2	22.8	1.6		60	21.2	23.0	1.8
1596	2	6.9	8.1	1.2	1760	2	15.3	*****	*****
	12	13.3	*****	*****		12	17.6	18.5	0.9
	32	17.2	*****	*****		32	18.3	20.1	1.8
	42	18.7	19.8	1.1		42	19.6	19.5	-0.1
	60	21.1	22.8	1.7		60	21.4	23.1	1.7
1601	2	6.3	8.0	1.7	1764	2	14.6	*****	*****
	12	13.7	*****	*****		12	17.7	18.8	1.1
	32	17.1	18.1	1.0		32	18.4	20.2	1.8
	42	19.1	19.9	0.8		42	19.9	21.2	1.3
	60	20.7	22.3	1.6		60	21.2	22.1	0.9
2292	2	6.8	6.9	0.1	2450	2	12.5	14.6	2.1
	12	12.3	15.5	3.2		12	16.0	*****	*****
	32	14.3	18.6	4.3		32	17.8	19.7	1.9
	42	18.2	19.6	1.4		42	19.6	20.6	1.0
	60	19.5	21.8	2.3		60	20.7	22.2	1.5
2296	2	6.6	6.6	0.0	2460	2	12.8	15.2	2.4
	12	13.5	14.8	1.3		12	16.7	18.6	1.9
	32	16.7	18.0	1.3		32	18.1	19.7	1.6
	42	18.3	19.3	1.0		42	19.4	20.7	1.3
	60	20.4	22.3	1.9		60	21.0	22.9	1.9
2301	2	6.6	6.7	0.1	2464	2	13.1	14.7	1.6
	12	13.4	14.6	1.2		12	17.5	18.8	1.3
	32	16.6	17.8	1.2		32	18.4	19.8	1.4
	42	18.4	19.4	1.0		42	19.7	20.8	1.1
	60	20.1	21.7	1.6		60	21.1	22.9	1.8
2310	2	7.2	7.7	0.5	2469	2	13.7	15.6	1.9
	12	12.9	14.5	1.6		12	*****	19.2	*****
	32	15.7	17.5	1.8		32	18.6	20.1	1.5
	42	17.4	19.1	1.7		42	19.8	21.1	1.3
	60	19.8	21.6	1.8		60	20.8	22.5	1.7

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: PO-06-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	2	*****	5.9	*****	686	2	13.1	15.0	1.9
	12	*****	9.6	*****		12	14.0	15.2	1.2
	22	*****	11.7	*****		22	14.3	15.9	1.6
	42	*****	13.2	*****		42	14.5	16.4	1.9
	62	*****	17.0	*****		62	15.0	17.0	2.0
510	2	*****	*****	*****	696	2	13.1	13.6	0.5
	12	*****	*****	*****		12	14.2	*****	*****
	22	*****	*****	*****		22	14.5	14.9	0.4
	42	*****	*****	*****		42	15.1	15.2	0.1
	62	*****	*****	*****		62	15.7	16.8	1.1
520	2	*****	2.6	*****	700	2	14.2	15.2	1.0
	12	*****	6.6	*****		12	14.8	15.3	0.5
	22	*****	9.1	*****		22	15.0	15.5	0.5
	42	*****	11.1	*****		42	15.3	15.8	0.5
	62	*****	17.0	*****		62	15.3	*****	*****
532	2	*****	6.7	*****	705	2	14.7	15.4	0.7
	12	*****	8.6	*****		12	15.0	15.4	0.4
	22	*****	9.3	*****		22	15.1	15.5	0.4
	42	*****	10.1	*****		42	15.3	16.1	0.8
	62	*****	15.0	*****		62	15.4	17.1	1.7
892	2	2.3	3.2	0.9	1350	2	13.3	14.0	0.7
	12	5.8	8.0	2.2		12	13.9	15.3	1.4
	22	8.3	10.7	2.4		22	14.6	15.5	0.9
	42	10.7	12.8	2.1		42	14.2	15.9	1.7
	62	15.6	18.6	3.0		62	15.7	17.4	1.7
896	2	5.1	5.9	0.8	1360	2	13.9	14.9	1.0
	12	8.2	9.2	1.0		12	14.2	*****	*****
	22	9.2	11.0	1.8		22	14.6	*****	*****
	42	10.6	12.0	1.4		42	15.2	16.2	1.0
	62	15.6	18.0	2.4		62	16.2	17.6	1.4
901	2	5.4	6.7	1.3	1372	2	14.3	15.9	1.6
	12	8.5	10.1	1.6		12	14.7	16.2	1.5
	22	9.7	11.4	1.7		22	14.8	16.4	1.6
	42	10.4	12.3	1.9		42	15.2	16.6	1.4
	62	14.8	18.0	3.2		62	15.6	17.0	1.4
910	2	4.3	5.9	1.6	1377	2	14.6	16.0	1.4
	12	8.6	10.5	1.9		12	14.9	16.5	1.6
	22	9.7	11.8	2.1		22	15.0	16.5	1.5
	42	10.3	12.5	2.2		42	15.4	16.8	1.4
	62	15.4	18.9	3.5		62	15.6	17.4	1.8
1502	2	2.2	2.8	0.6	1741	2	11.7	11.9	0.2
	12	6.7	6.7	0.0		12	12.2	12.7	0.5
	22	8.2	8.8	0.6		22	12.5	13.0	0.5
	42	9.6	10.2	0.6		42	12.9	13.3	0.4
	62	15.6	17.2	1.6		62	13.9	15.5	1.6
1592	2	1.7	2.5	0.8	1750	2	9.9	11.0	1.1
	12	4.6	5.2	0.6		12	12.4	13.5	1.1
	22	6.9	7.5	0.6		22	12.8	13.7	0.9
	42	8.7	9.4	0.7		42	13.4	14.0	0.6
	62	12.9	15.1	2.2		62	15.2	16.5	1.3
1596	2	3.4	3.3	-0.1	1760	2	10.6	10.7	0.1
	12	6.2	6.4	0.2		12	12.7	*****	*****
	22	7.0	7.3	0.3		22	13.4	15.6	2.2
	42	8.2	8.8	0.6		42	14.4	14.5	0.1
	62	12.7	15.2	2.5		62	16.2	15.2	-1.0
1601	2	3.0	3.7	0.7	1764	2	13.2	*****	*****
	12	5.4	6.2	0.8		12	13.7	14.6	0.9
	22	7.0	7.6	0.6		22	13.9	14.8	0.9
	42	7.9	8.3	0.4		42	14.1	15.0	0.9
	62	13.3	14.5	1.2		62	14.9	15.3	0.4
2292	2	1.9	1.7	-0.2	2450	2	9.3	9.9	0.6
	12	4.6	5.3	0.7		12	11.5	12.5	1.0
	22	7.3	7.3	0.0		22	12.2	13.1	0.9
	42	9.7	10.1	0.4		42	12.9	13.5	0.6
	62	13.7	15.7	2.0		62	14.7	16.3	1.6
2296	2	4.9	*****	*****	2460	2	8.6	10.4	1.8
	12	7.1	5.9	-1.2		12	10.6	12.7	2.1
	22	7.6	7.3	-0.3		22	12.8	13.6	0.8
	42	8.5	8.9	0.4		42	13.7	14.3	0.6
	62	12.5	14.3	1.8		62	15.4	16.5	1.1
2301	2	3.1	2.8	-0.3	2464	2	12.2	12.1	-0.1
	12	5.4	5.8	0.4		12	12.9	13.5	0.6
	22	7.3	7.4	0.1		22	13.0	13.0	0.0
	42	8.1	8.4	0.3		42	13.6	14.4	0.8
	62	12.4	15.0	2.6		62	14.2	15.6	1.4
2310	2	3.4	3.5	0.1	2469	2	12.9	13.3	0.4
	12	6.0	5.6	-0.4		12	13.1	14.1	1.0
	22	7.0	7.2	0.2		22	13.5	14.2	0.7
	42	8.2	8.5	0.3		42	13.7	14.4	0.7
	62	14.1	15.4	1.3		62	14.4	15.7	1.3

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: PR-03-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	2	0.9	0.7	-0.2	686	2	13.3	15.4	2.1
	22	12.7	13.4	0.7		22	13.4	15.8	2.4
	52	12.7	13.8	1.1		52	13.9	15.9	2.0
510	2	2.9	3.1	0.2	696	2	11.7	15.5	3.8
	22	7.8	8.9	1.1		22	****	15.9	****
	52	8.3	9.9	1.6		52	****	16.0	****
520	2	2.4	2.8	0.4	700	2	****	15.7	****
	22	7.6	8.5	0.9		22	****	16.0	****
	52	7.7	9.4	1.7		52	****	****	****
532	2	4.0	4.6	0.6	705	2	****	15.5	****
	22	7.6	8.9	1.3		22	****	16.0	****
	52	7.8	9.6	1.8		52	****	16.0	****
892	2	4.8	7.1	2.3	1350	2	****	15.3	****
	22	11.5	13.2	1.7		22	13.8	16.0	2.2
	52	12.0	****	****		52	13.9	16.1	2.2
896	2	6.3	7.8	1.5	1360	2	13.7	15.5	1.8
	22	11.4	13.0	1.6		22	14.4	16.4	2.0
	52	11.7	13.5	1.8		52	14.6	16.5	1.9
901	2	5.9	7.6	1.7	1372	2	14.1	15.8	1.7
	22	10.8	12.6	1.8		22	14.5	16.5	2.0
	52	11.2	13.2	2.0		52	14.7	16.6	1.9
910	2	****	8.2	****	1377	2	14.2	15.8	1.6
	22	****	12.2	****		22	14.7	16.6	1.9
	52	****	12.6	****		52	14.8	16.7	1.9
1502	2	2.6	2.5	-0.1	1741	2	9.4	****	****
	22	9.0	10.2	1.2		22	12.2	****	****
	52	9.4	10.7	1.3		52	12.4	****	****
1592	2	1.3	****	****	1750	2	10.6	****	****
	22	7.7	****	****		22	12.2	****	****
	52	8.5	****	****		52	12.5	****	****
1596	2	2.3	****	****	1760	2	9.8	****	****
	22	7.8	****	****		22	12.7	****	****
	52	1.3	****	****		52	12.9	****	****
1601	2	2.1	****	****	1764	2	10.9	****	****
	22	7.7	****	****		22	12.9	****	****
	52	8.2	****	****		52	13.0	****	****
2292	2	2.3	2.8	0.5	2450	2	10.7	12.7	2.0
	22	9.1	10.2	1.1		22	12.3	13.6	1.3
	52	9.6	10.5	0.9		52	12.5	13.7	1.2
2296	2	3.5	4.4	0.9	2460	2	9.7	12.3	2.6
	22	8.7	9.9	1.2		22	12.8	14.0	1.2
	52	9.1	10.2	1.1		52	12.9	14.2	1.3
2301	2	2.9	4.3	1.4	2464	2	11.3	12.9	1.6
	22	8.3	9.7	1.4		22	13.1	14.3	1.2
	52	8.6	10.0	1.4		52	13.2	14.3	1.1
2310	2	4.2	4.5	0.3	2469	2	11.2	13.1	1.9
	22	8.2	9.5	1.3		22	13.1	14.3	1.2
	52	8.4	9.0	1.4		52	13.2	14.5	1.3

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: R-03-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	13	17.8	****	****	606	13	18.5	20.7	2
	26	19.3	****	****		26	19.0	****	****
	46	19.5	20.8	1.3		46	19.8	21.8	[illegible]
	59	19.6	20.9	1.3		59	19.6	22.2	2.6
510	13	17.6	18.7	1.1	696	13	18.0	[illegible]	[illegible]
	26	18.4	****	****		26	19.6	****	****
	46	19.0	20.5	1.5		46	19.6	21.9	2.3
	59	19.7	20.8	1.1		59	20.5	22.3	1.8
520	13	14.8	17.9	3.1	700	13	****	21.1	****
	26	17.4	18.6	1.2		26	****	****	****
	46	17.4	19.2	1.8		46	****	21.8	****
	59	18.4	19.8	1.4		59	****	22.1	****
532	13	16.6	17.5	0.9	705	13	****	21.3	****
	26	16.9	18.1	1.2		26	****	****	****
	46	17.2	18.7	1.5		46	****	22.1	****
	59	17.6	19.4	1.8		59	****	22.6	****
802	13	17.8	18.3	0.5	1350	13	19.0	19.5	0.5
	26	18.7	19.1	0.4		26	19.6	20.1	0.5
	46	19.2	20.0	0.8		46	20.3	****	****
	59	20.0	20.0	0.0		59	20.6	20.7	0.1
806	13	18.0	18.1	0.1	1360	13	19.6	19.0	-0.6
	26	18.7	****	****		26	20.0	****	****
	46	19.0	19.0	0.0		46	20.6	****	****
	59	19.3	20.0	0.7		59	21.0	21.2	0.2
901	13	17.7	18.0	0.3	1372	13	20.1	20.4	0.3
	26	18.6	18.9	0.3		26	20.2	20.8	0.6
	46	18.9	19.3	0.4		46	20.4	21.1	0.7
	59	19.0	19.6	0.6		59	20.5	21.3	0.8
910	13	18.0	18.1	0.1	1377	13	20.1	20.5	0.4
	26	18.2	18.8	0.6		26	20.2	****	****
	46	18.9	19.2	0.3		46	20.4	21.0	0.6
	59	19.1	19.7	0.6		59	20.7	21.1	0.4
1502	13	16.6	17.2	0.6	1741	13	17.2	18.2	1.0
	26	17.5	****	****		26	17.6	19.0	1.4
	46	18.1	19.7	1.6		46	18.0	19.4	1.4
	59	18.6	20.3	1.7		59	18.4	19.5	1.1
1592	13	15.8	16.4	0.6	1750	13	17.9	19.0	1.1
	26	16.4	17.7	1.3		26	18.4	****	****
	46	17.1	18.7	1.6		46	19.1	20.3	1.2
	59	18.1	19.5	1.4		59	19.2	20.6	1.4
1596	13	15.6	16.3	0.7	1760	13	18.6	19.3	0.7
	26	16.4	17.8	1.4		26	18.9	20.4	1.5
	46	16.9	18.4	1.5		46	19.3	21.1	1.8
	59	17.4	18.9	1.5		59	19.7	21.7	2.0
1601	13	15.0	16.0	1.0	1764	13	18.5	18.6	0.1
	26	16.0	17.4	1.4		26	18.6	****	****
	46	16.6	18.1	1.5		46	19.1	19.4	0.3
	59	16.8	18.3	1.5		59	19.2	20.8	1.6
2292	13	15.6	16.7	1.1	2450	13	18.1	18.7	0.6
	26	16.8	18.0	1.2		26	18.0	19.5	1.5
	46	17.5	****	****		46	18.0	20.3	2.3
	59	18.0	19.7	1.7		59	17.4	20.4	3.0
2296	13	15.3	****	****	2460	13	16.3	19.2	2.9
	26	16.3	****	****		26	16.6	19.8	3.2
	46	16.9	18.8	1.9		46	18.4	20.7	2.3
	59	17.1	19.2	2.1		59	17.4	****	****
2301	13	14.8	16.4	1.6	2464	13	18.4	19.9	1.5
	26	15.0	****	****		26	18.9	****	****
	46	16.3	18.1	1.8		46	19.1	20.7	1.6
	59	16.5	18.5	2.0		59	19.2	****	****
2310	13	14.7	15.9	1.2	2469	13	18.4	19.8	1.4
	26	15.5	****	****		26	18.7	****	****
	46	16.0	17.7	1.7		46	19.1	20.5	1.4
	59	16.6	18.0	1.4		59	19.1	20.8	1.7

(Continued)

Table 4 (Continued)

SALINITY (PPT)
STATION: SA-02-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	4	2.2	2.8	0.6	686	4	5.2	9.0	3.8
	22	2.5	4.0	1.5		22	6.0	9.8	3.8
	37	7.2	8.2	1.0		37	8.0	10.3	2.3
510	4	0.5	1.0	0.5	696	4	5.1	9.3	4.2
	22	2.2	3.5	1.3		22	****	10.5	****
	37	6.9	8.1	1.2		37	****	11.0	****
520	4	0.2	0.7	0.5	700	4	****	9.9	****
	22	1.9	2.9	1.0		22	****	10.6	****
	37	6.7	7.7	1.0		37	****	10.7	****
532	4	0.5	0.7	0.2	705	4	****	10.1	****
	22	1.6	2.6	1.0		22	****	10.5	****
	37	6.3	7.5	1.2		37	****	10.5	****
892	4	0.7	1.2	0.5	1358	4	4.7	6.0	1.3
	22	2.1	2.2	0.1		22	6.0	6.7	0.7
	37	7.1	9.5	2.4		37	6.7	8.0	1.3
896	4	****	1.2	****	1368	4	4.8	5.9	1.1
	22	1.5	1.8	0.3		22	7.2	8.7	1.5
	37	****	9.2	****		37	7.7	9.1	1.4
901	4	****	0.9	****	1372	4	5.9	7.6	1.7
	22	****	1.6	****		22	7.3	8.3	1.0
	37	****	9.2	****		37	7.8	8.3	0.5
910	4	****	0.8	****	1377	4	5.9	8.0	2.1
	22	****	1.6	****		22	7.2	8.1	0.9
	37	****	8.9	****		37	7.3	8.7	1.4
1502	4	0.4	0.3	-0.1	1741	4	3.2	4.0	0.8
	22	0.6	0.6	0.0		22	4.2	5.7	1.5
	37	0.6	5.3	4.7		37	4.8	6.7	1.9
1592	4	0.2	****	****	1750	4	3.7	4.0	0.3
	22	0.6	****	****		22	4.5	5.5	1.0
	37	0.5	****	****		37	5.5	6.4	0.9
1596	4	0.3	0.7	0.4	1760	4	3.9	****	****
	22	0.4	0.7	0.3		22	5.9	****	****
	37	0.6	4.3	3.7		37	6.3	****	****
1601	4	0.2	0.6	0.4	1764	4	4.7	****	****
	22	0.3	0.7	0.4		22	5.9	****	****
	37	0.6	3.9	3.3		37	6.3	****	****
2292	4	0.2	0.5	0.3	2458	4	2.9	3.5	0.6
	22	0.3	0.7	0.4		22	3.5	3.9	0.4
	37	0.5	1.6	1.1		37	4.5	4.7	0.2
2296	4	0.2	0.5	0.3	2460	4	3.1	3.9	0.8
	22	0.3	0.6	0.3		22	5.3	6.1	0.8
	37	0.4	1.6	1.2		37	5.7	6.8	1.1
2301	4	0.2	0.4	0.2	2464	4	3.7	4.8	1.1
	22	0.3	0.6	0.3		22	5.2	5.9	0.7
	37	0.3	1.3	1.0		37	6.0	7.1	1.1
2310	4	0.2	0.4	0.2	2469	4	3.6	4.4	0.8
	22	0.3	0.5	0.2		22	4.4	5.8	1.4
	37	0.3	1.0	0.7		37	5.6	6.9	1.3

(Continued)

Table 4 (Concluded)

SALINITY (PPT)
STATION: Y-05-01

		HIGH FLOW					LOW FLOW		
LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE	LUNAR DAY	DEPTH	BASE	FUTURE	FUTURE-BASE
509	4	7.9	9.3	1.4	686	4	17.3	18.6	1.3
	14	15.9	16.5	0.6		14	18.9	20.2	1.3
	26	17.0	17.7	0.7		26	19.3	20.5	1.2
510	4	7.2	7.1	-0.1	696	4	16.9	17.7	0.8
	14	16.9	18.8	1.9		14	18.7	20.4	1.7
	26	17.7	20.1	2.4		26	19.7	21.3	1.6
520	4	7.2	7.5	0.3	700	4	18.1	19.0	0.9
	14	17.0	18.2	1.2		14	19.4	20.1	0.7
	26	17.9	18.7	0.8		26	19.5	20.3	0.8
532	4	11.2	*****	*****	705	4	18.5	19.4	0.9
	14	15.7	16.6	0.9		14	19.5	20.3	0.8
	26	16.1	*****	*****		26	19.8	*****	*****
892	4	5.1	5.9	0.8	1350	4	19.1	19.5	0.4
	14	16.3	19.3	3.0		14	20.0	20.2	0.2
	26	*****	20.0	*****		26	20.4	20.4	0.0
896	4	9.9	10.8	0.9	1360	4	19.3	19.7	0.4
	14	17.0	17.8	0.8		14	21.0	20.8	-0.2
	26	17.6	17.9	0.3		26	21.2	21.1	-0.1
901	4	9.4	10.3	0.9	1372	4	19.6	20.0	0.4
	14	15.6	16.2	0.6		14	20.9	20.8	-0.1
	26	16.4	16.7	0.3		26	20.9	20.8	-0.1
910	4	9.0	9.4	0.4	1377	4	19.7	20.0	0.3
	14	16.9	17.5	0.6		14	21.0	20.9	-0.1
	26	*****	18.2	*****		26	20.9	21.1	0.2
1502	4	5.2	5.7	0.5	1741	4	15.1	17.2	2.1
	14	15.0	17.0	2.0		14	17.2	18.9	1.7
	26	16.9	18.5	1.6		26	17.6	19.1	1.5
1592	4	4.5	6.8	2.3	1750	4	15.6	18.0	2.4
	14	15.7	16.0	0.3		14	17.6	19.7	2.1
	26	17.3	18.7	1.4		26	18.1	19.8	1.7
1596	4	9.2	9.9	0.7	1760	4	14.7	*****	*****
	14	15.0	*****	*****		14	18.2	18.8	0.6
	26	15.7	16.6	0.9		26	19.4	*****	*****
1601	4	8.0	10.5	2.5	1764	4	16.2	*****	*****
	14	13.9	14.7	0.8		14	17.8	*****	*****
	26	14.4	15.5	1.1		26	18.4	*****	*****
2292	4	7.3	7.6	0.3	2450	4	17.1	19.8	2.7
	14	16.0	21.8	5.8		14	17.8	23.0	5.2
	26	17.4	22.7	5.3		26	18.0	23.2	5.2
2296	4	11.9	10.7	-1.2	2460	4	17.6	19.6	2.0
	14	15.6	19.4	3.8		14	18.6	23.9	5.3
	26	16.5	20.1	3.6		26	18.9	24.9	6.0
2301	4	11.2	12.0	0.8	2464	4	17.2	21.6	4.4
	14	14.0	18.1	4.1		14	17.9	23.2	5.3
	26	15.2	18.9	3.7		26	18.0	23.7	5.7
2310	4	9.0	9.5	0.5	2469	4	17.3	21.6	4.3
	14	13.9	20.1	6.2		14	18.2	23.6	5.4
	26	15.2	20.5	5.3		26	18.3	23.9	5.6

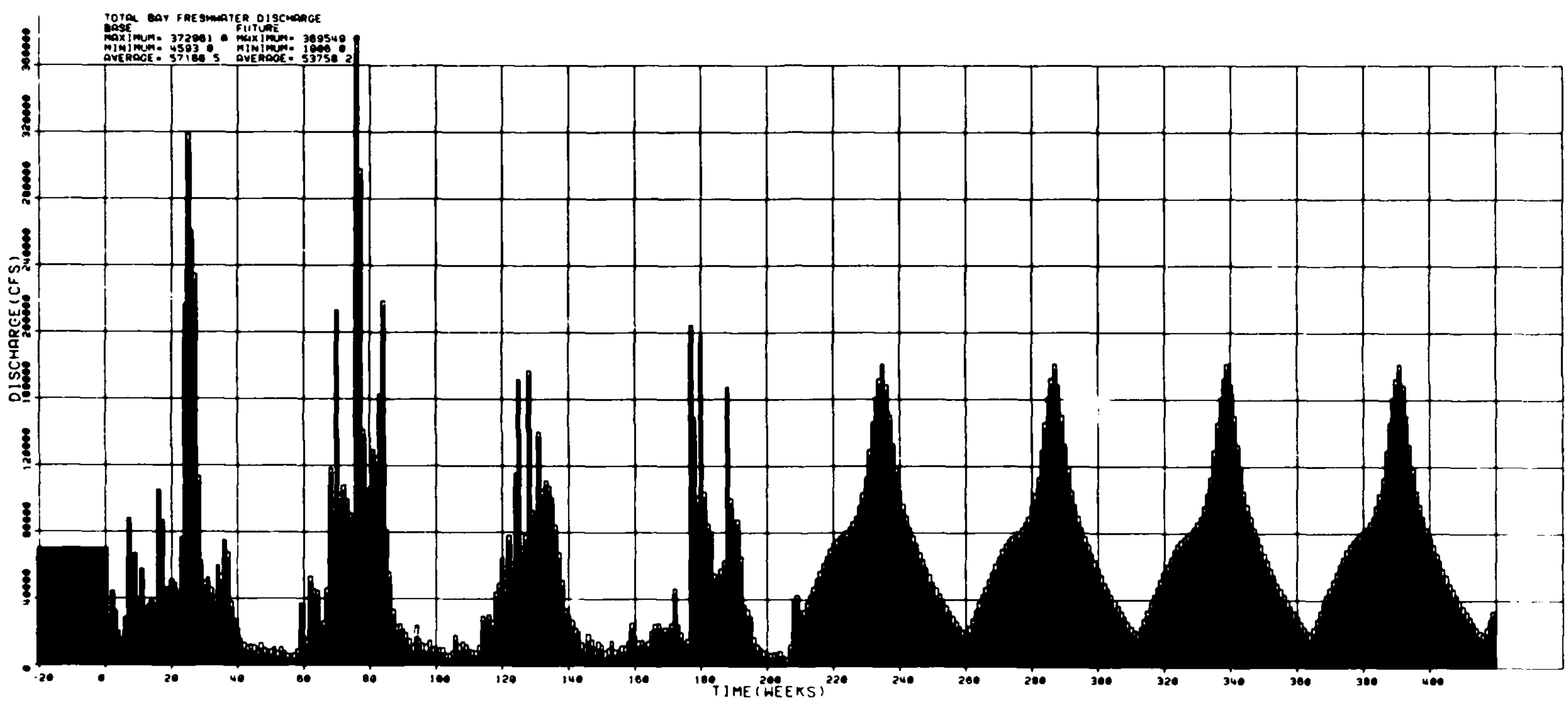


Plate 1. Total bay discharge hydrograph

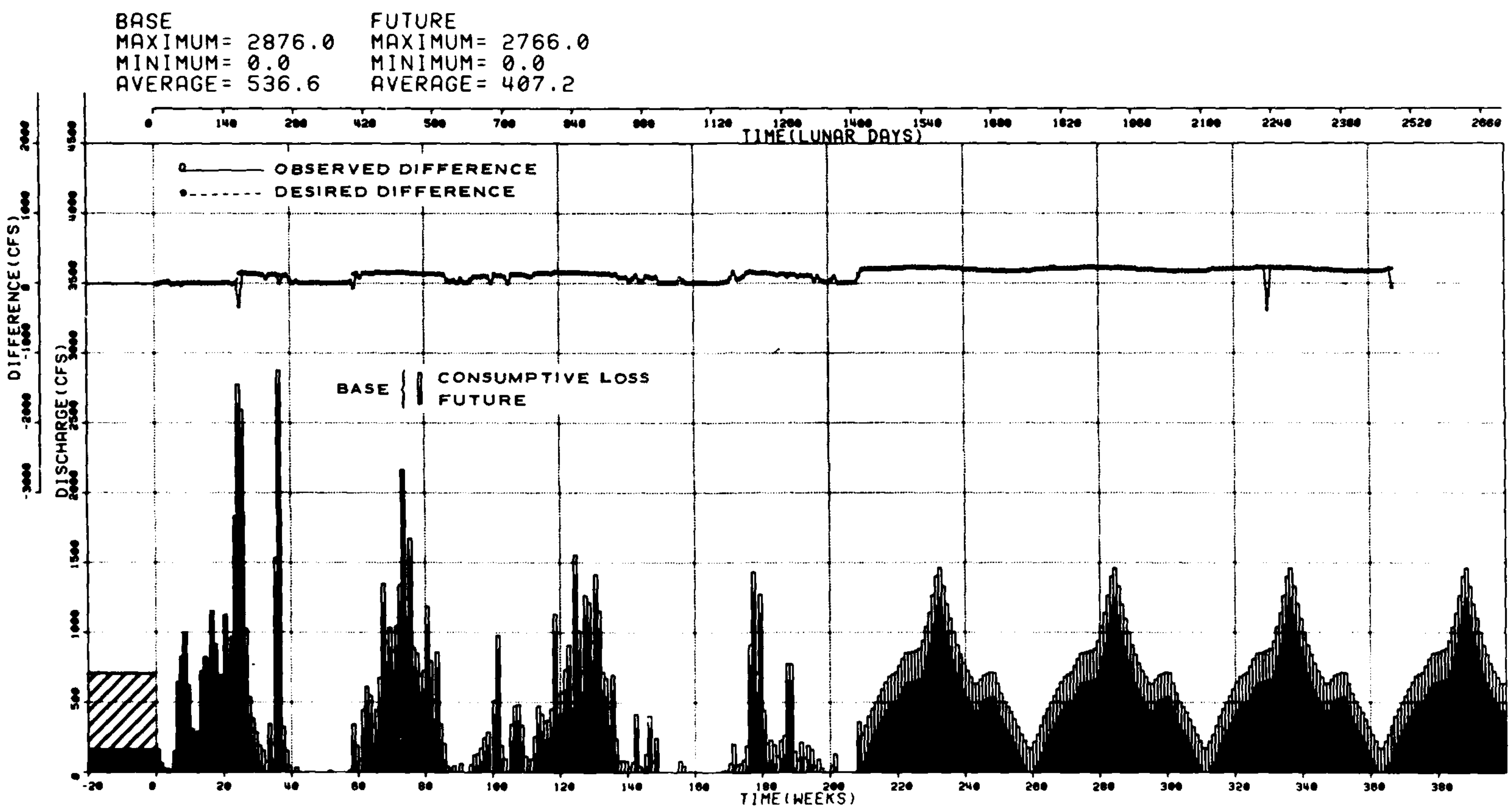


Plate 2. Discharge hydrograph, inflow 1, Nansemond River

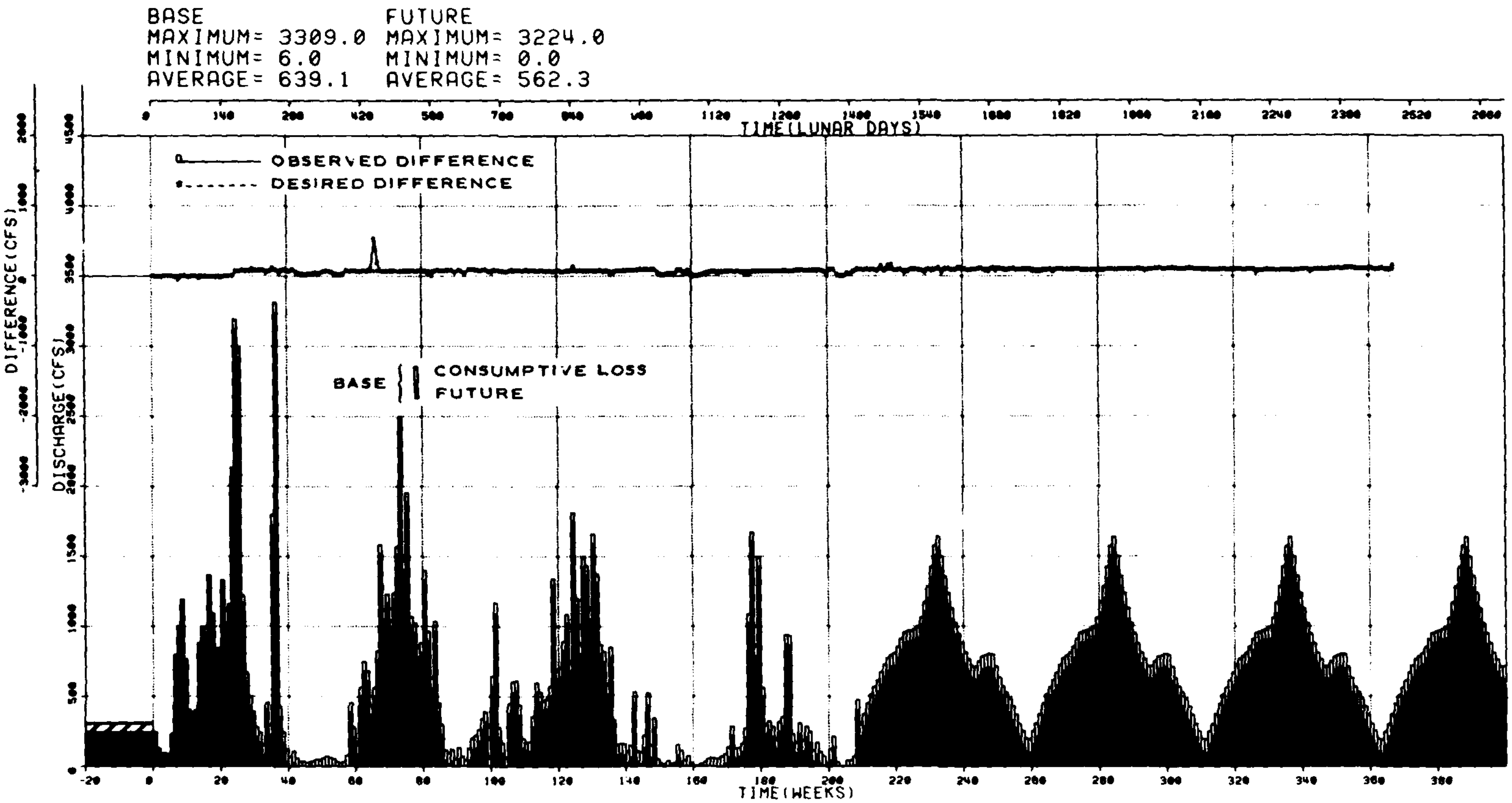


Plate 3. Discharge hydrograph, inflow 2, Chickahominy River

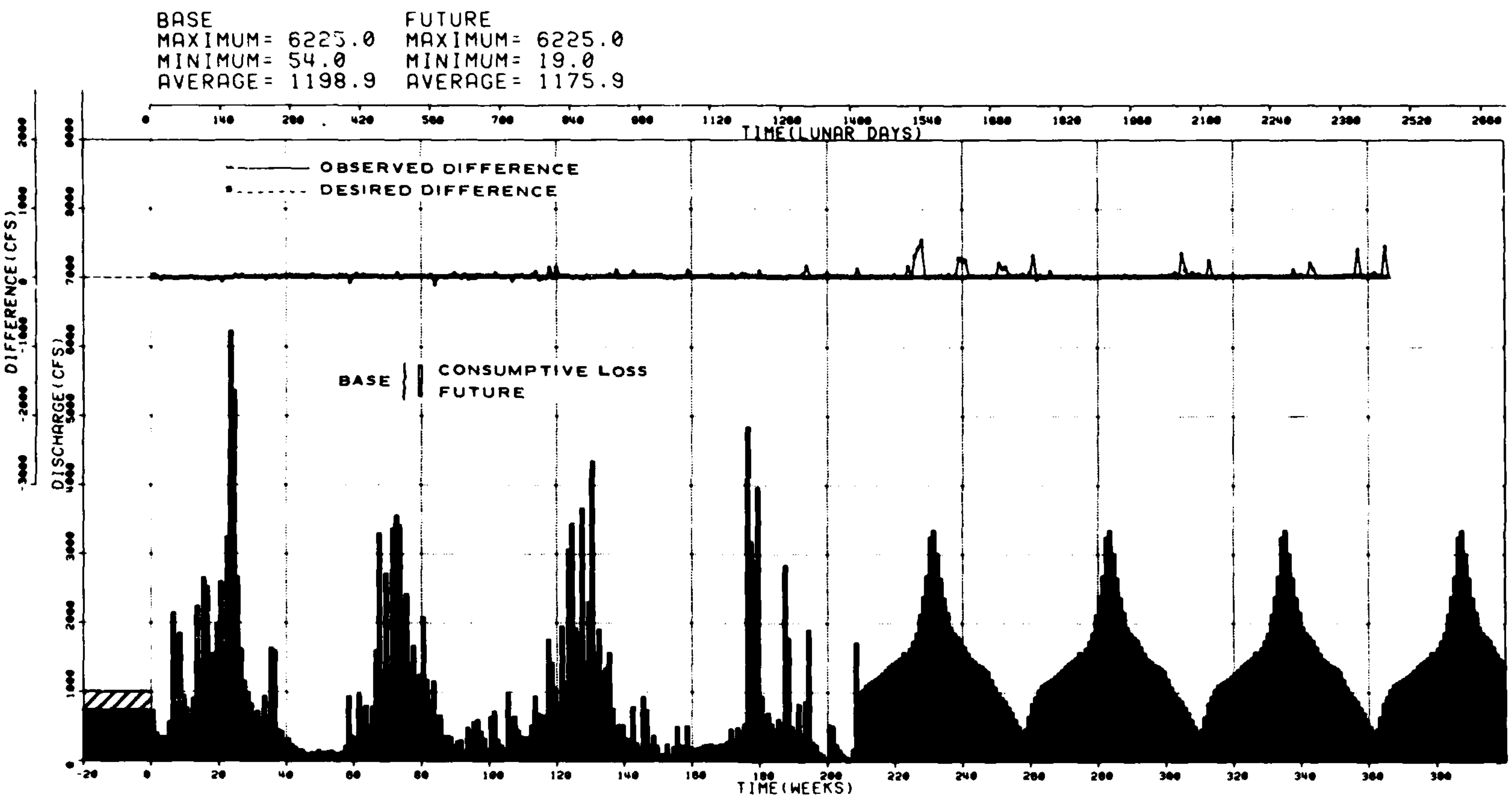


Plate 4. Discharge hydrograph, inflow 3, Appomattox River

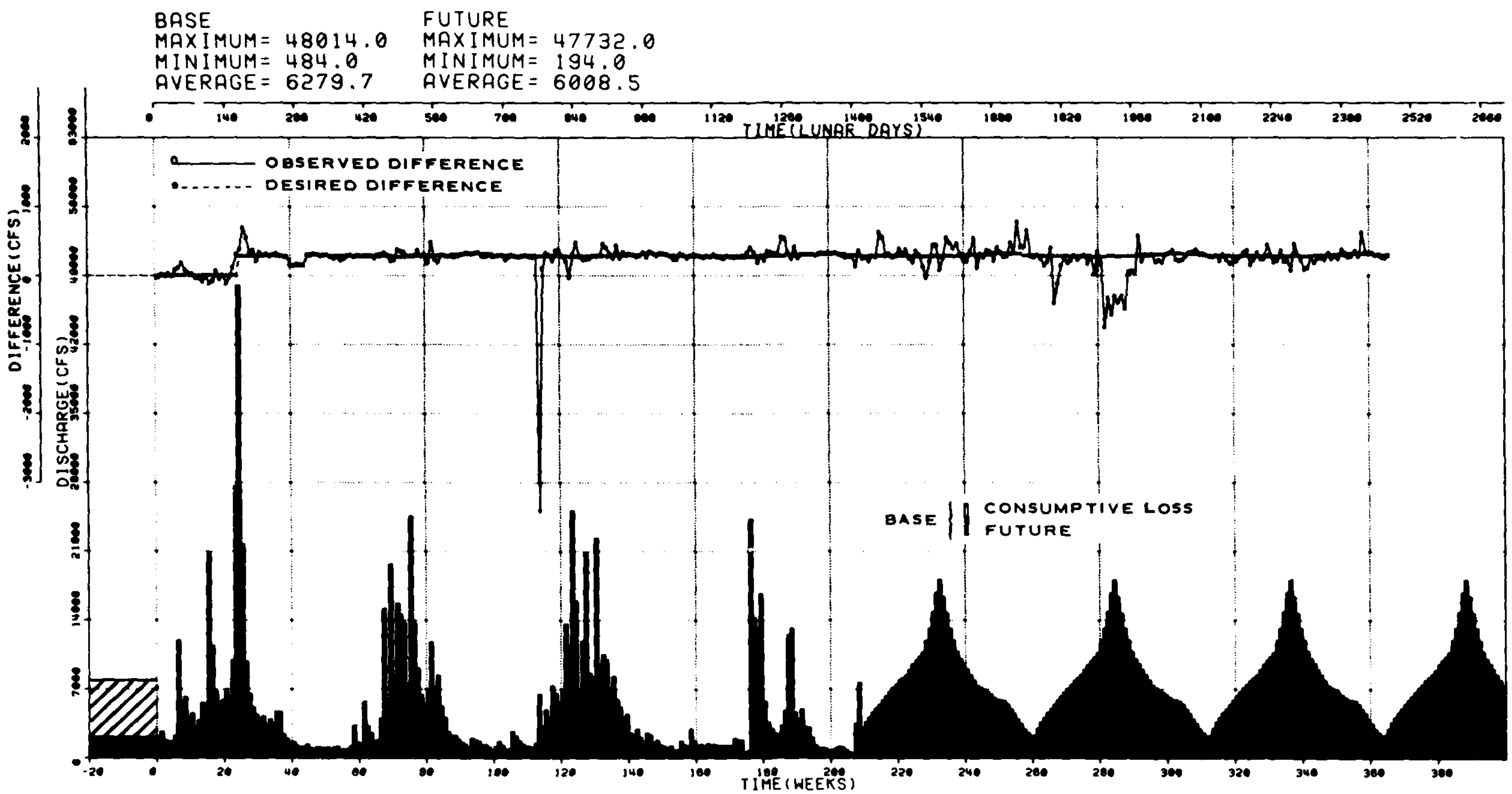


Plate 5. Discharge hydrograph, inflow 4, James River

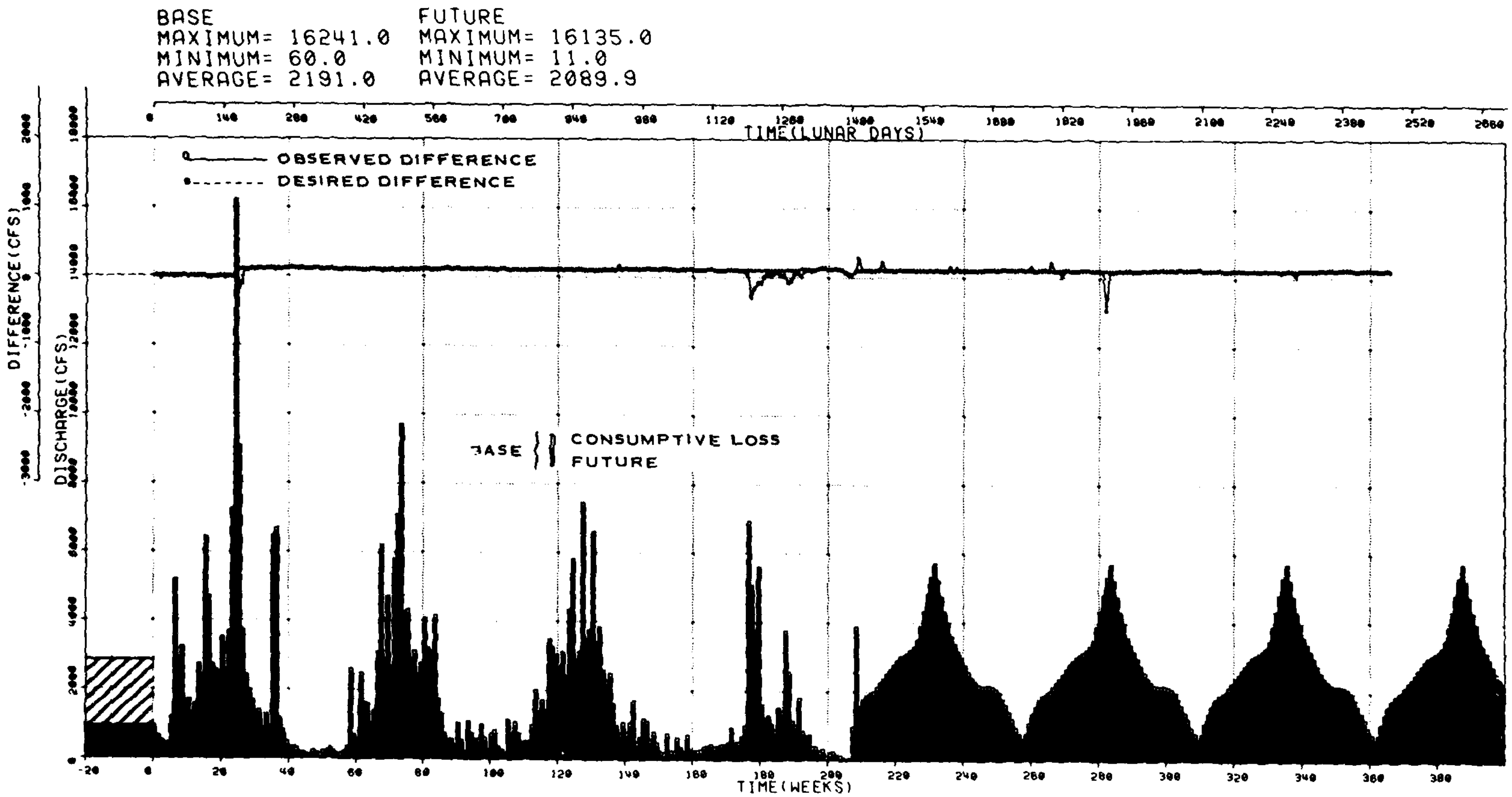


Plate 6. Discharge hydrograph, *inflow* 5, York River

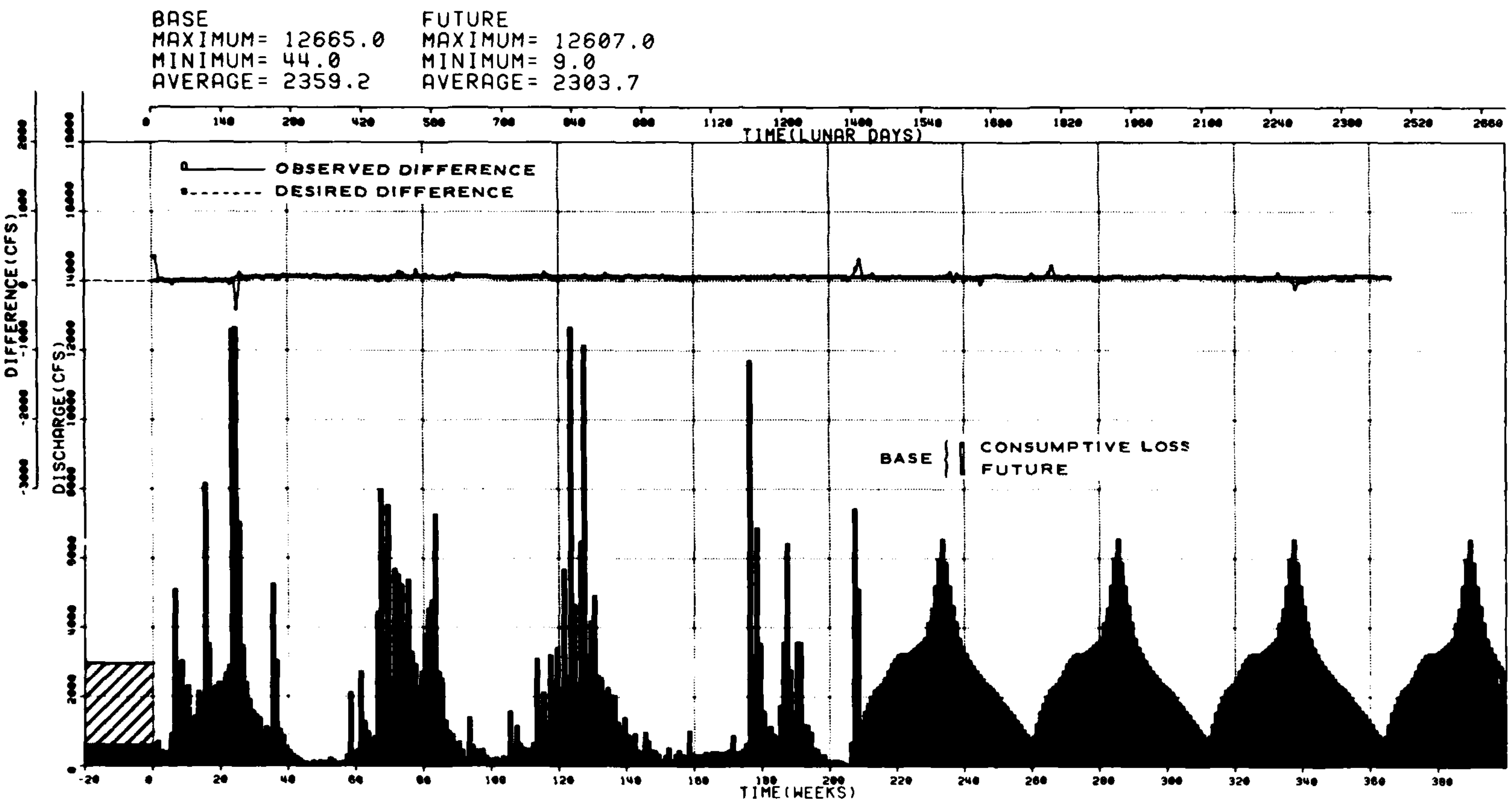


Plate 7. Discharge hydrograph, inflow 6, Rappahannock River

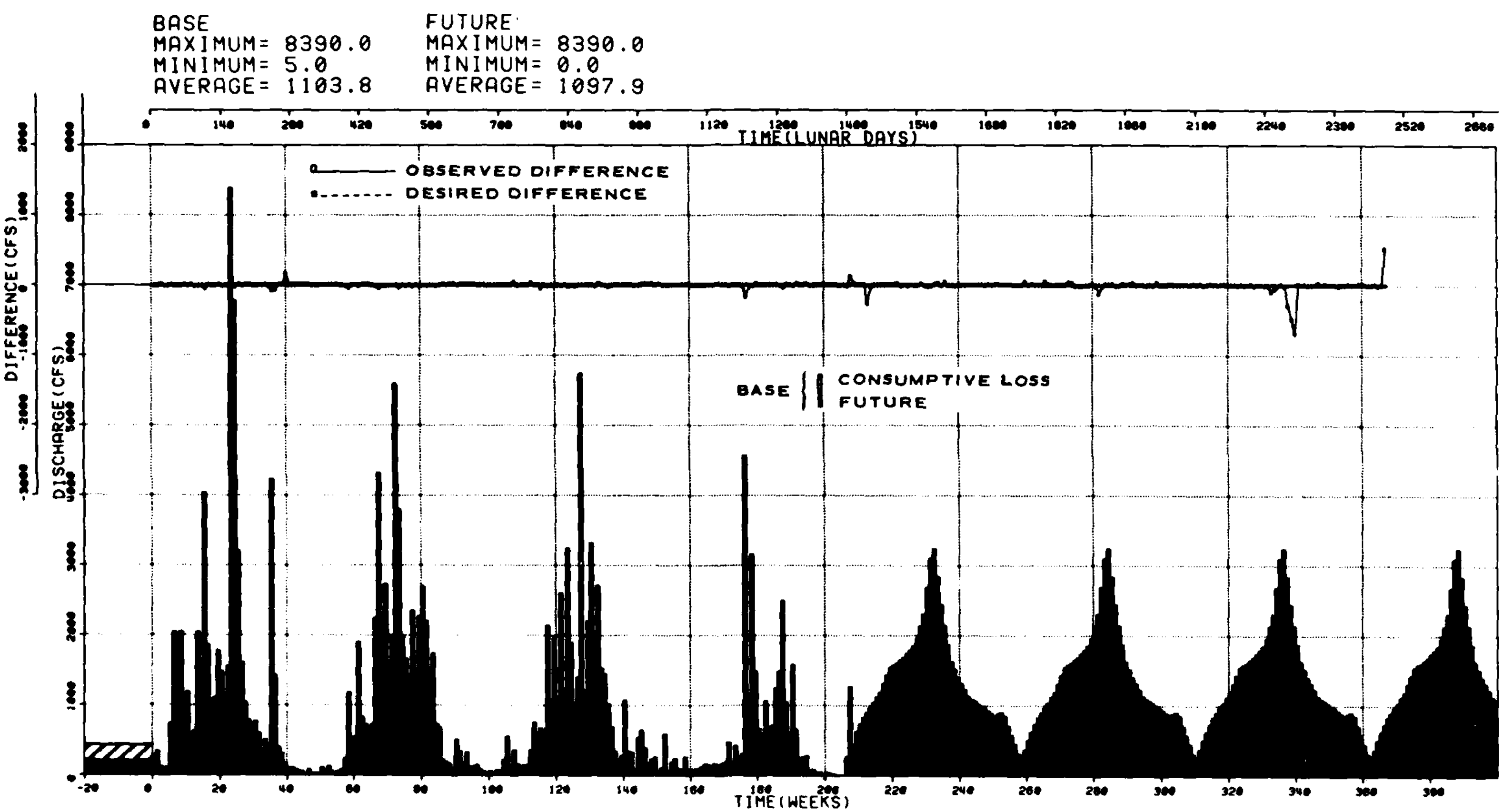


Plate 8. Discharge hydrograph, inflow 7, Wicomico (Potomac) River

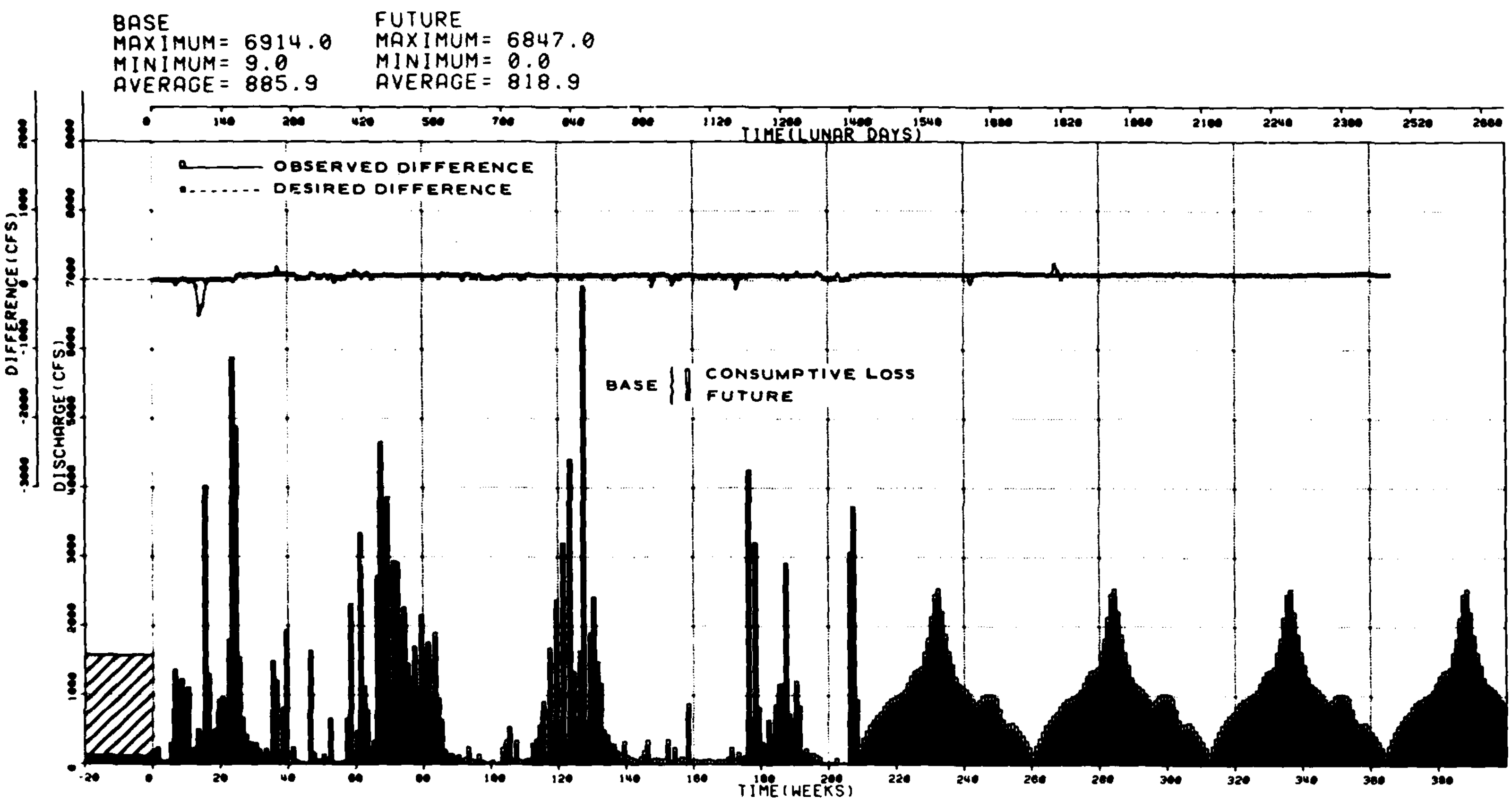


Plate 9. Discharge hydrograph, inflow 8, Occoquan Creek

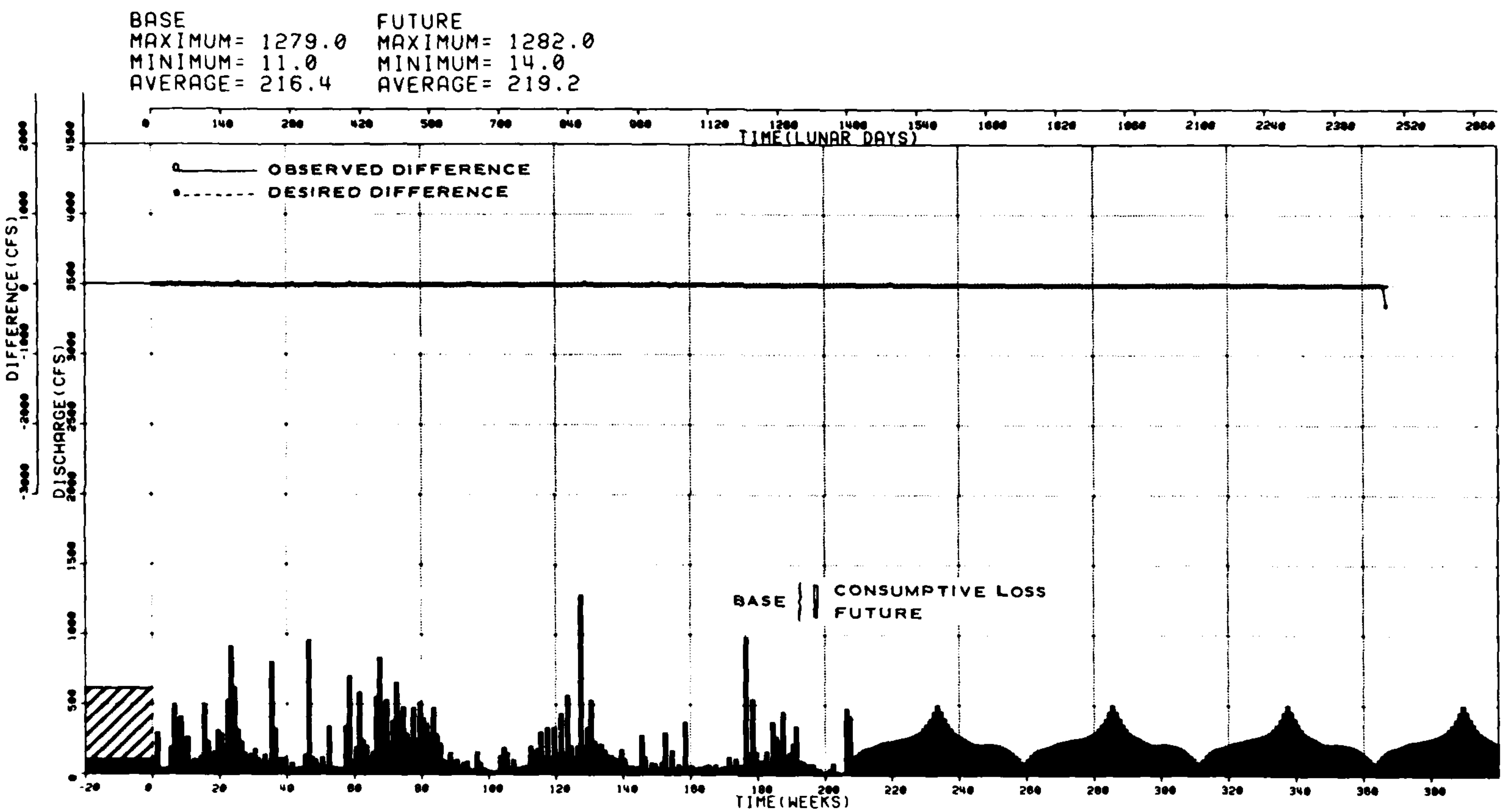


Plate 10. Discharge hydrograph, inflow 9, Anacostia River

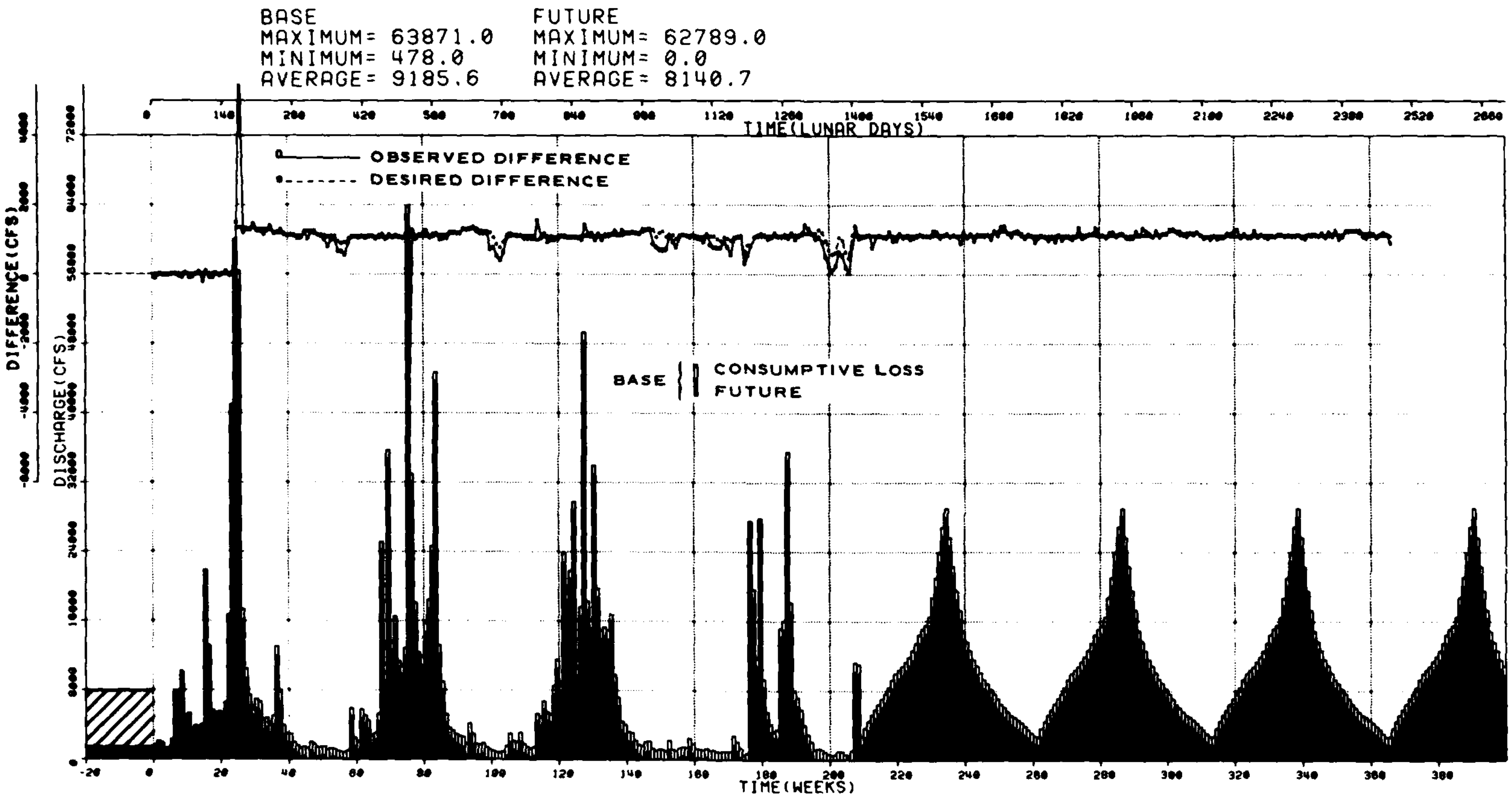


Plate 11. Discharge hydrograph, inflow 10, Potomac River

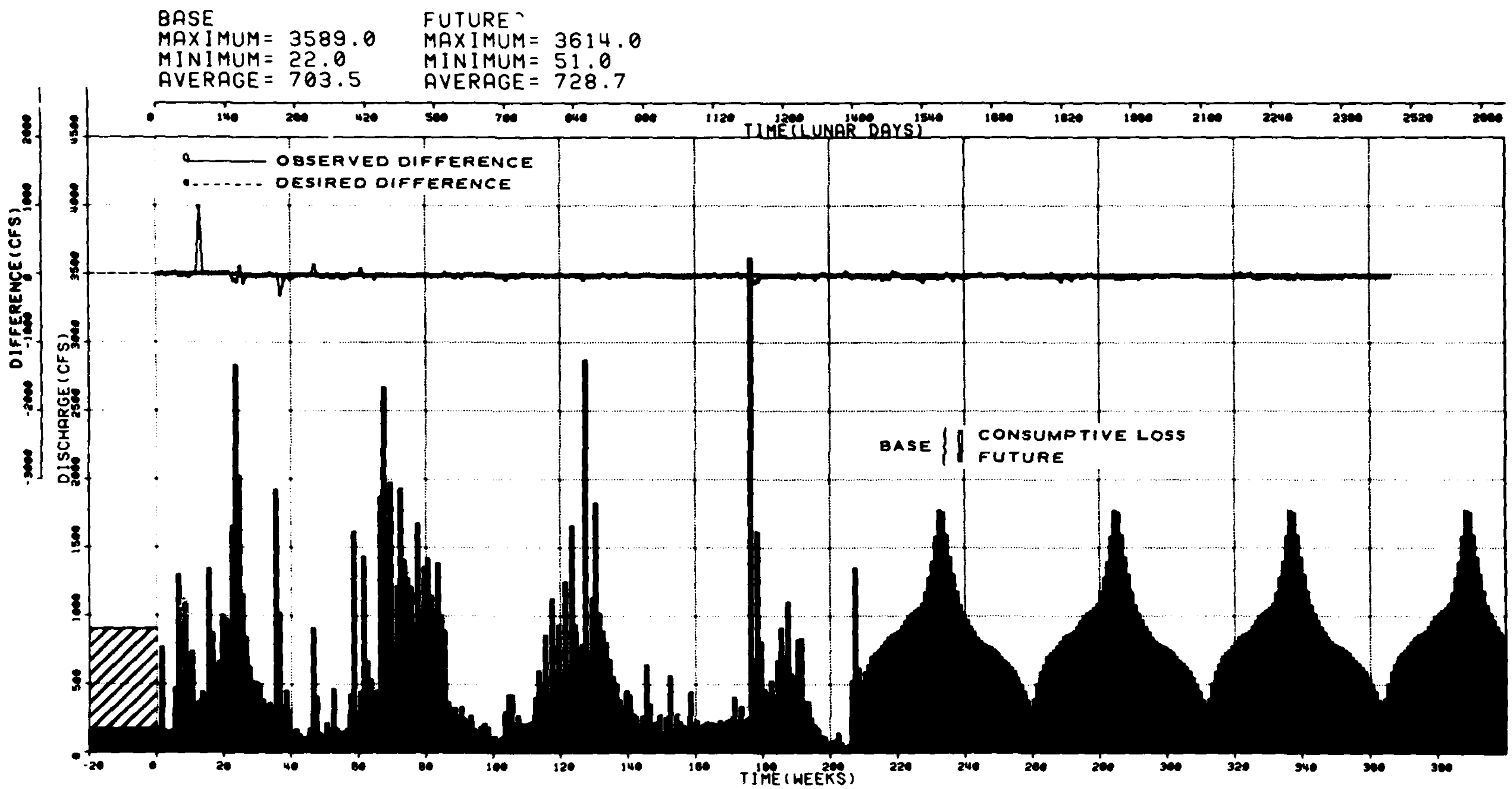


Plate 12. Discharge hydrograph, inflow 11, Patuxent River

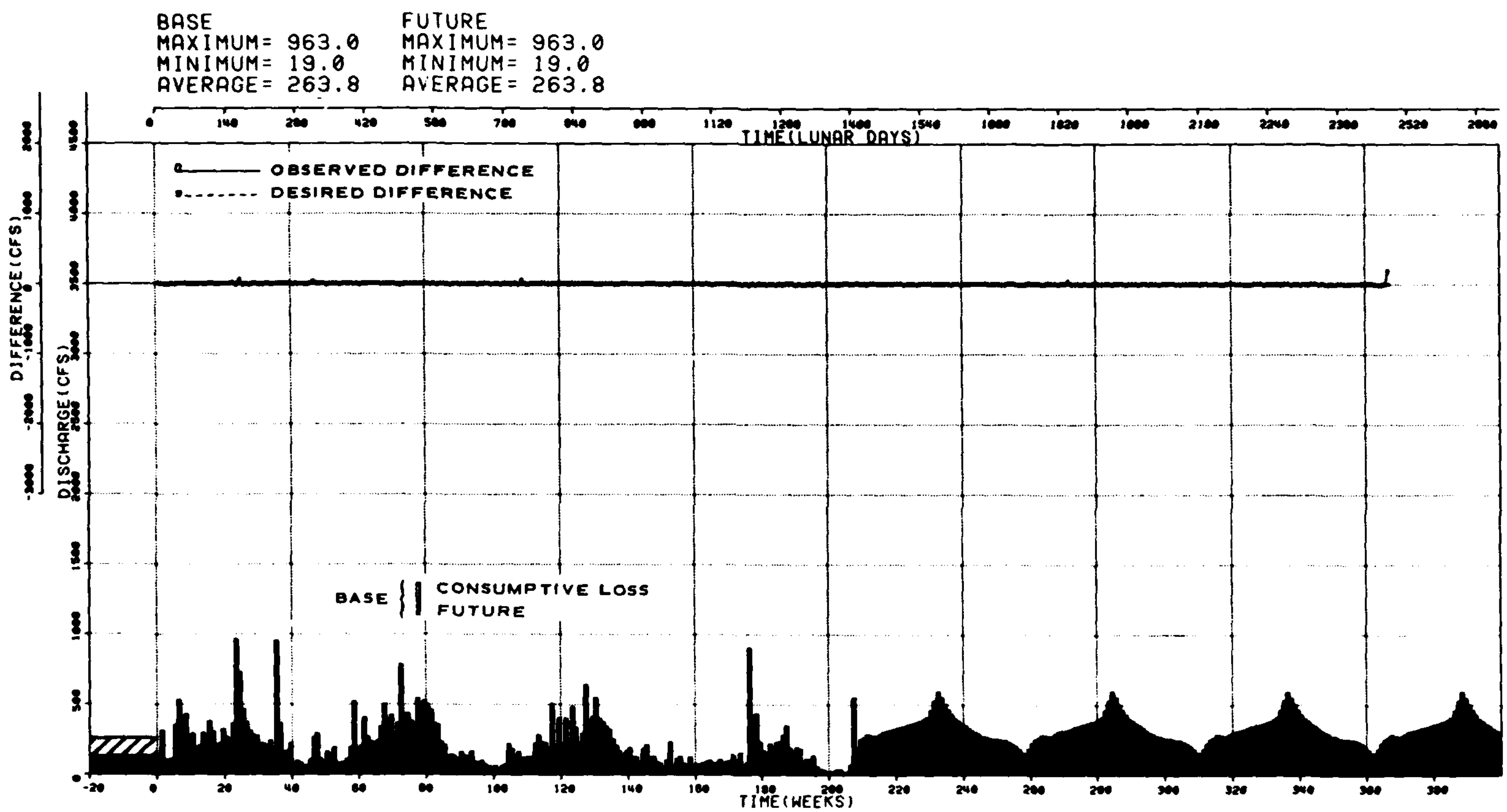


Plate 13. Discharge hydrograph, inflow 12, Severn River

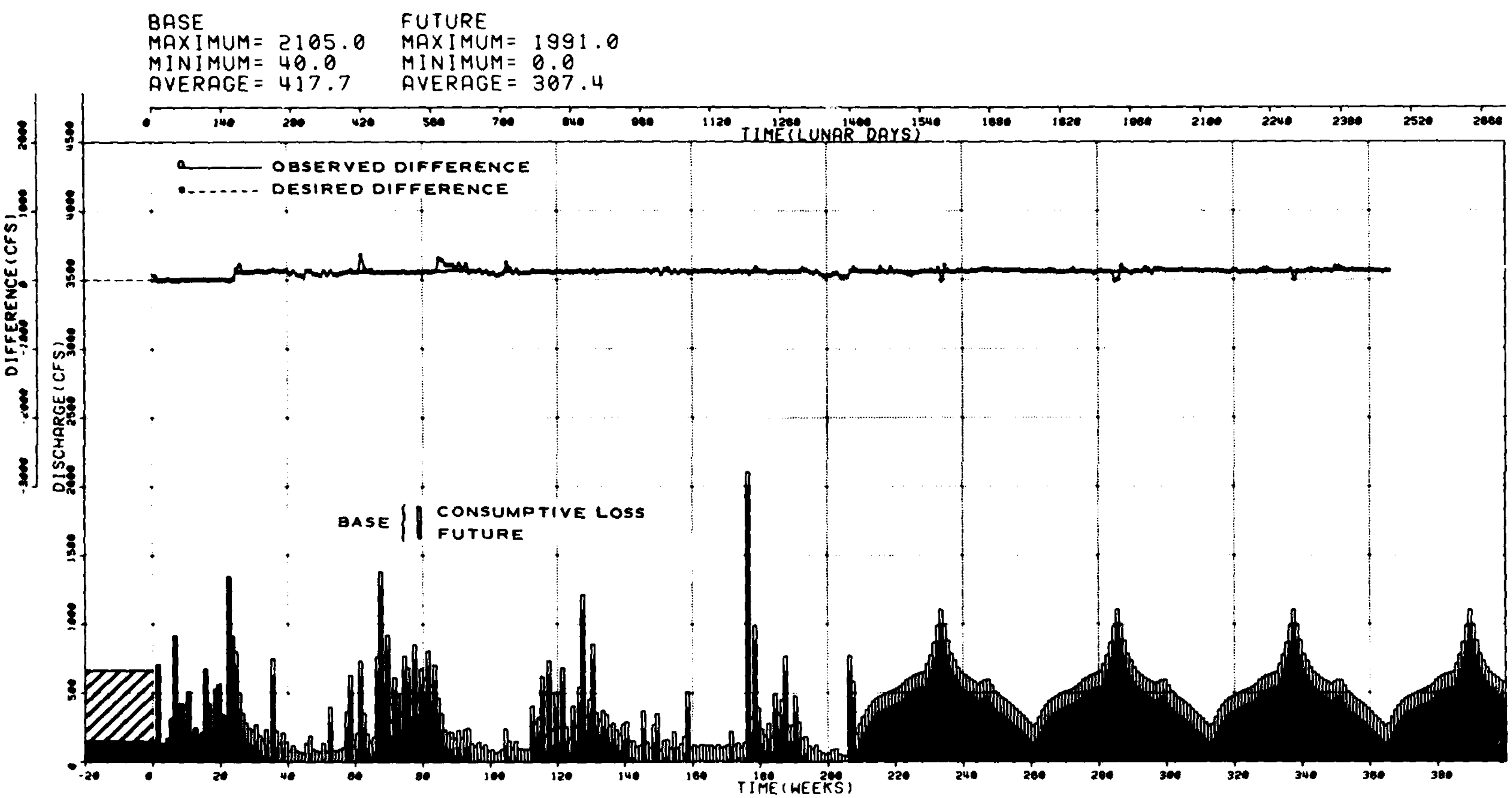


Plate 14. Discharge hydrograph, inflow 13, Patapsco River

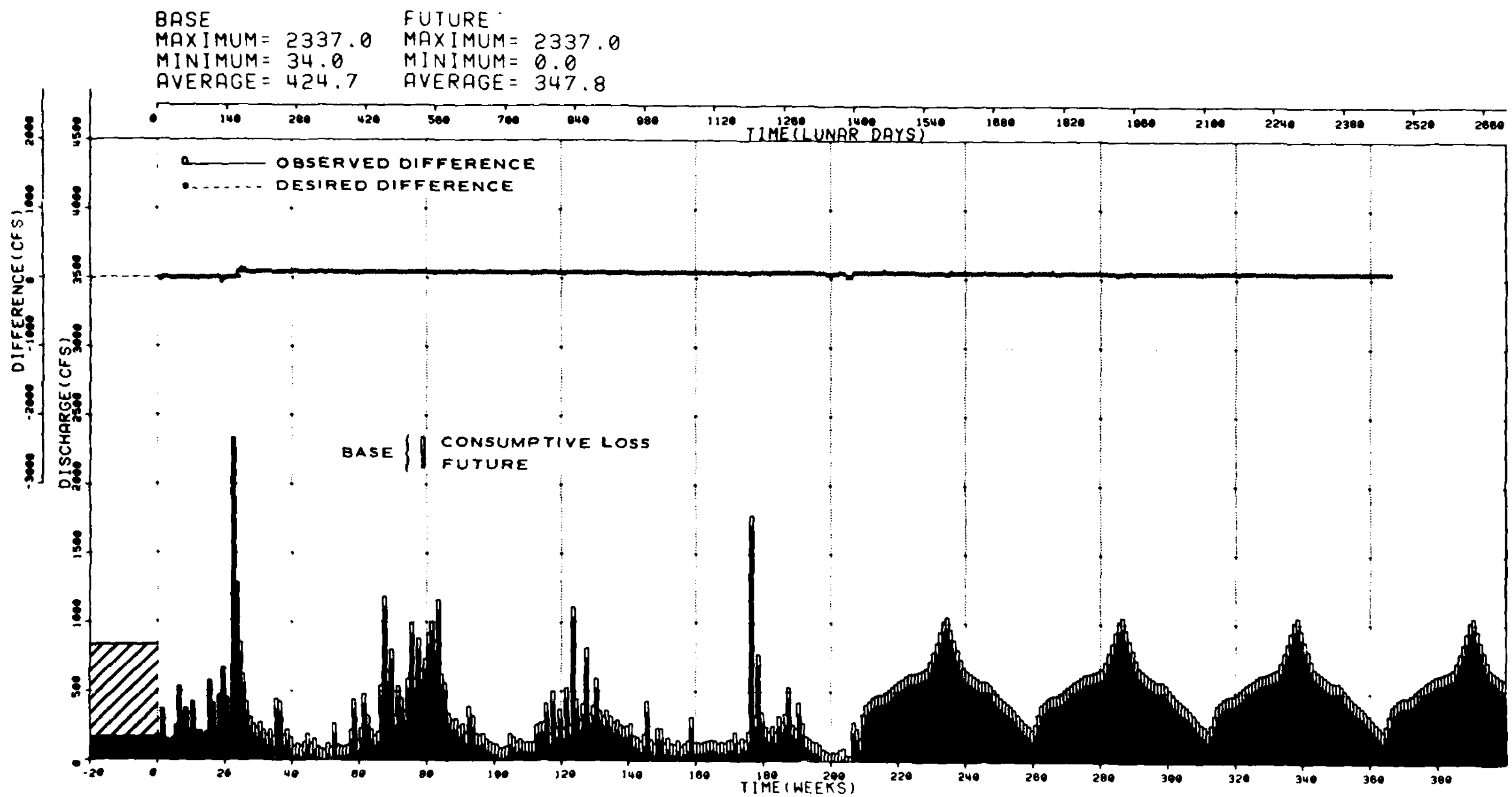


Plate 15. Discharge hydrograph, inflow 14, Gunpowder River

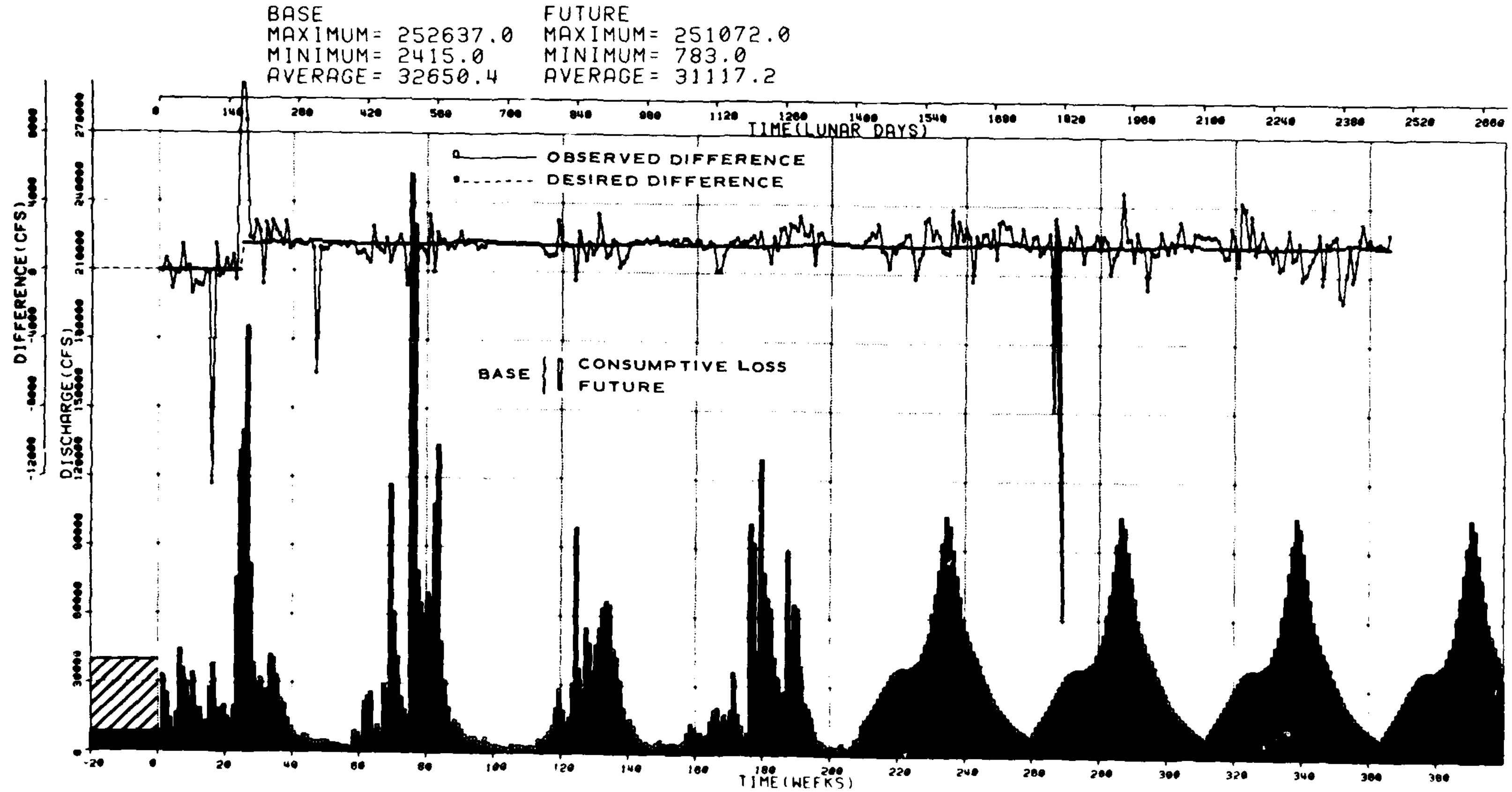
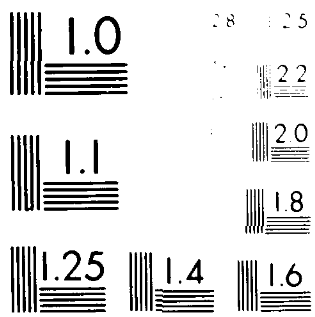


Plate 16. Discharge hydrograph, inflow 15, Susquehanna River

AD-A112 215 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 8/8
LOW FRESHWATER INFLOW STUDY. CHESAPEAKE BAY HYDRAULIC MODEL INV--ETC(U)
JAN 82 D R RICHARDS, L F GULBRANDSEN
UNCLASSIFIED WES/TR/HL-82-3 NL

2 OF 3
AD A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2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

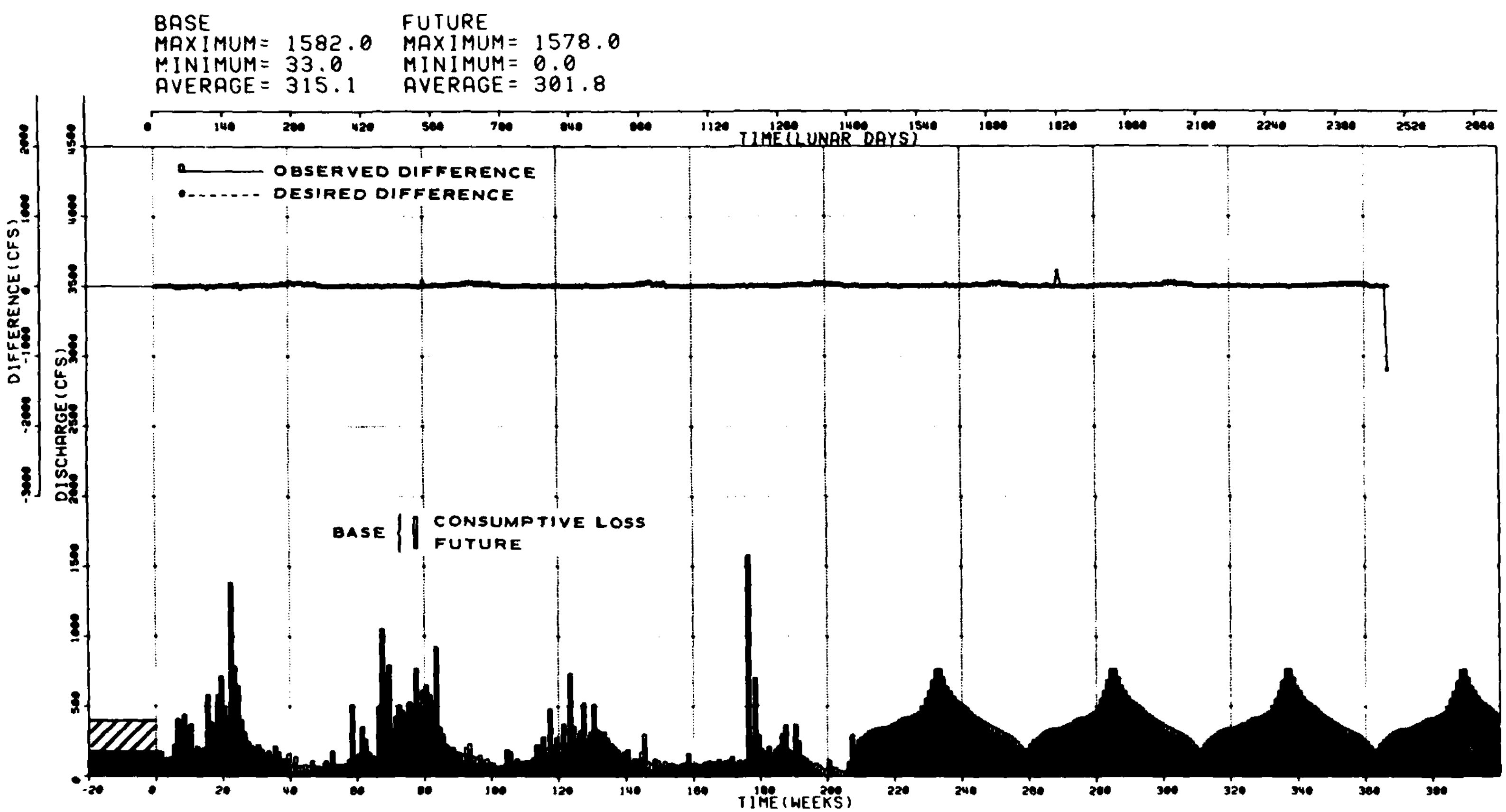


Plate 17. Discharge hydrograph, inflow 16, Bohemia River

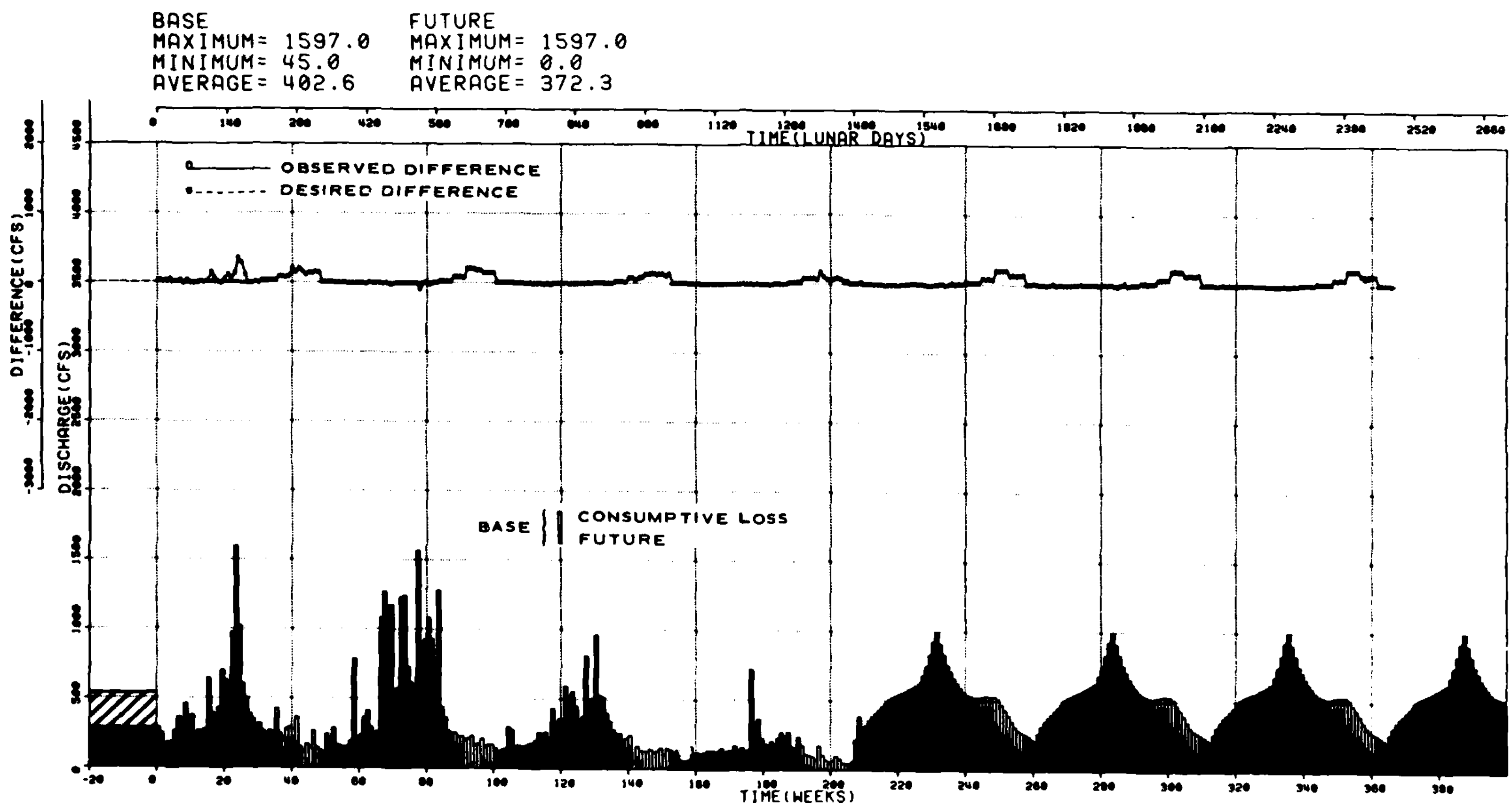


Plate 18. Discharge hydrograph, inflow 17, Chester River

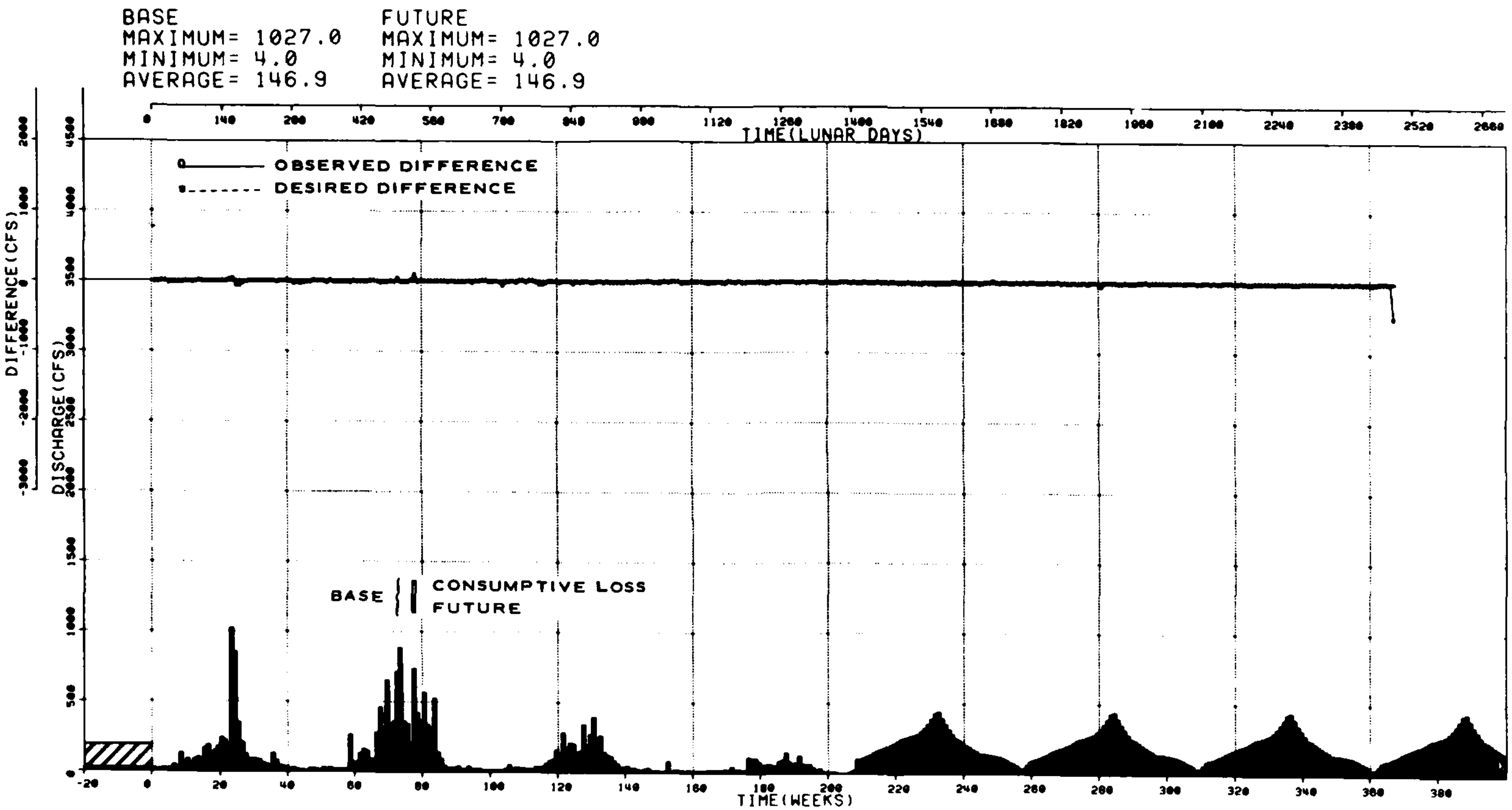


Plate 19. Discharge hydrograph, inflow 18, Wye River

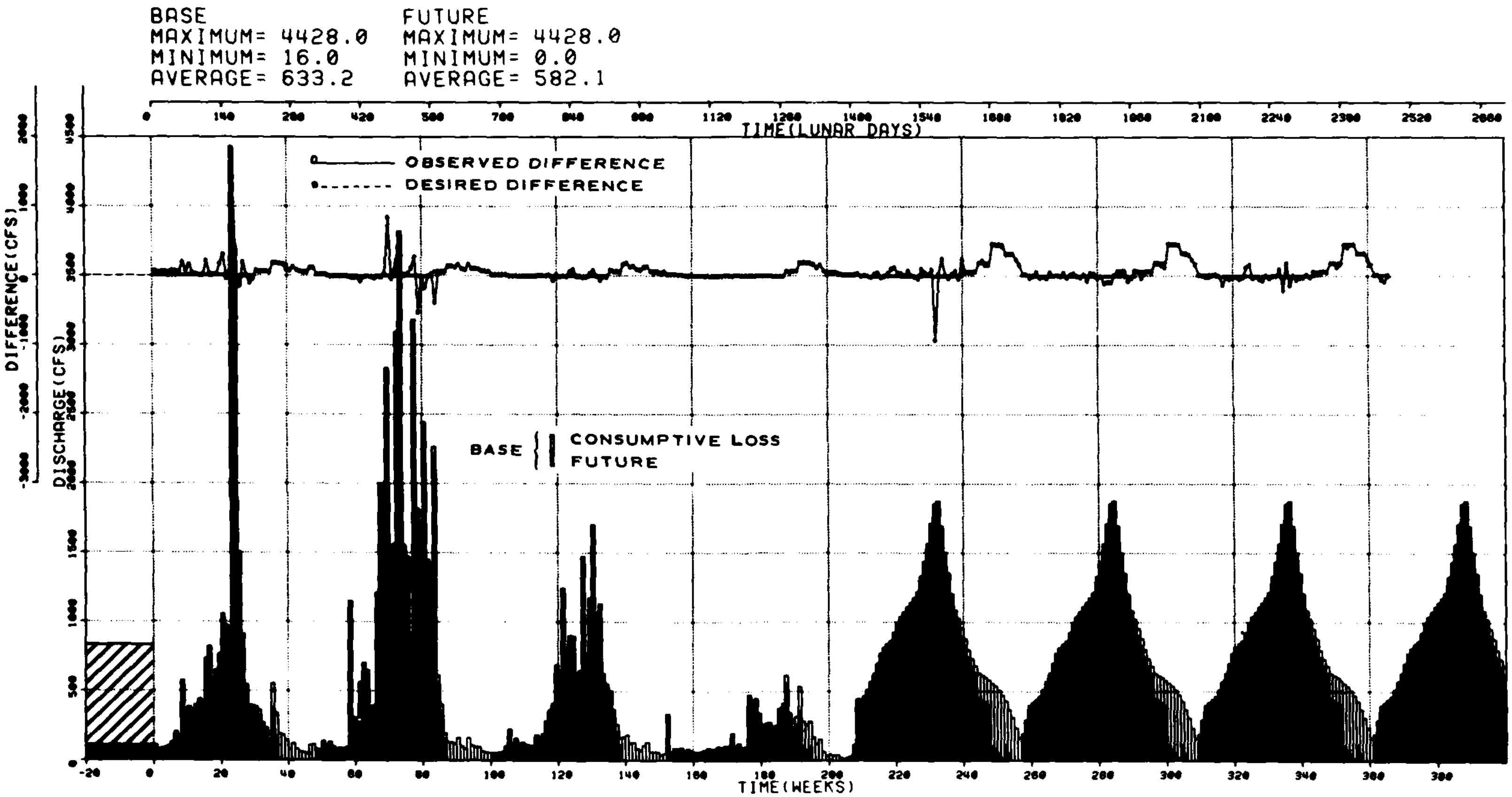


Plate 20. Discharge hydrograph, inflow 19, Choptank River

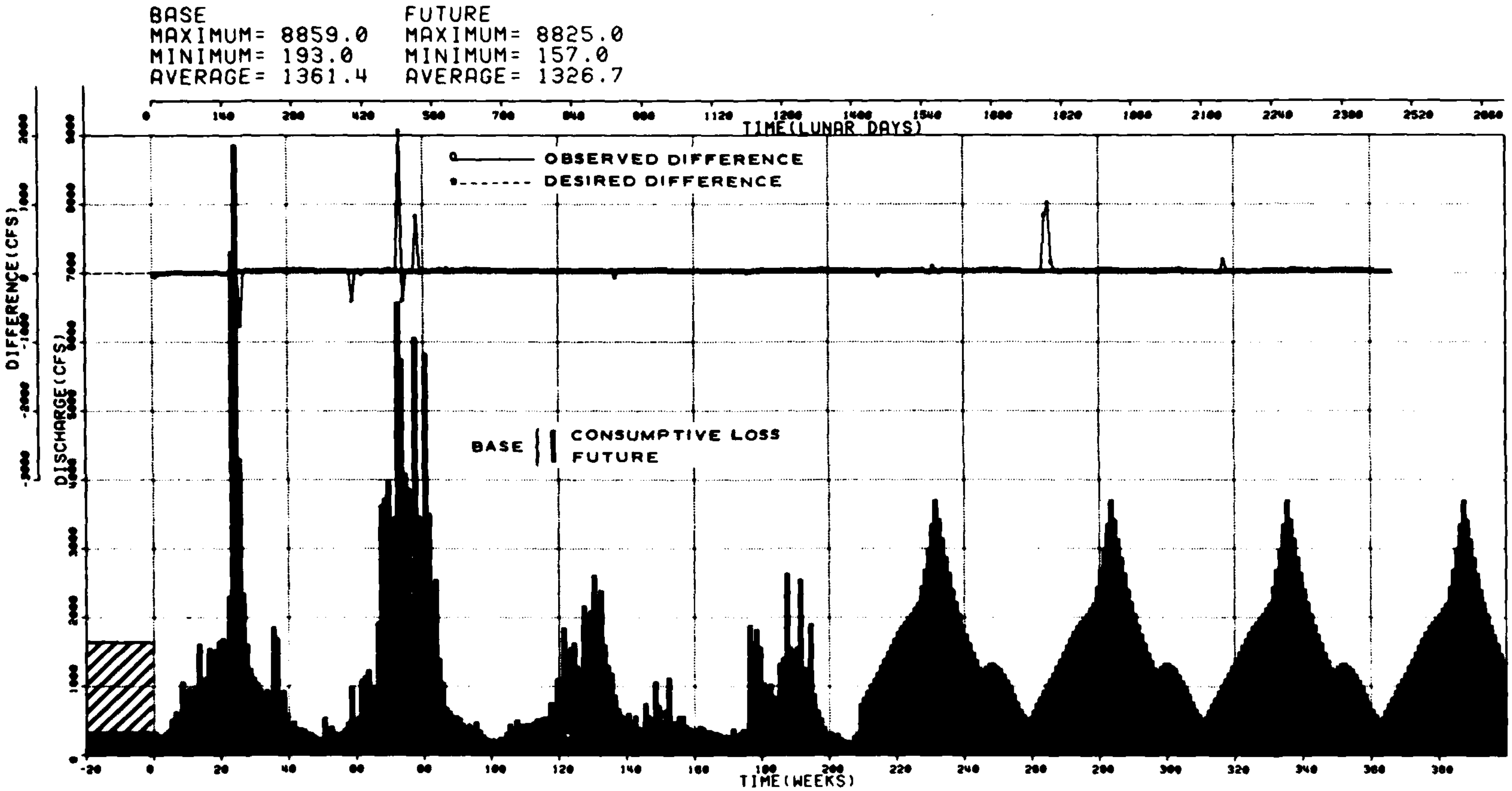


Plate 21. Discharge hydrograph, inflow 20, Nanticoke River

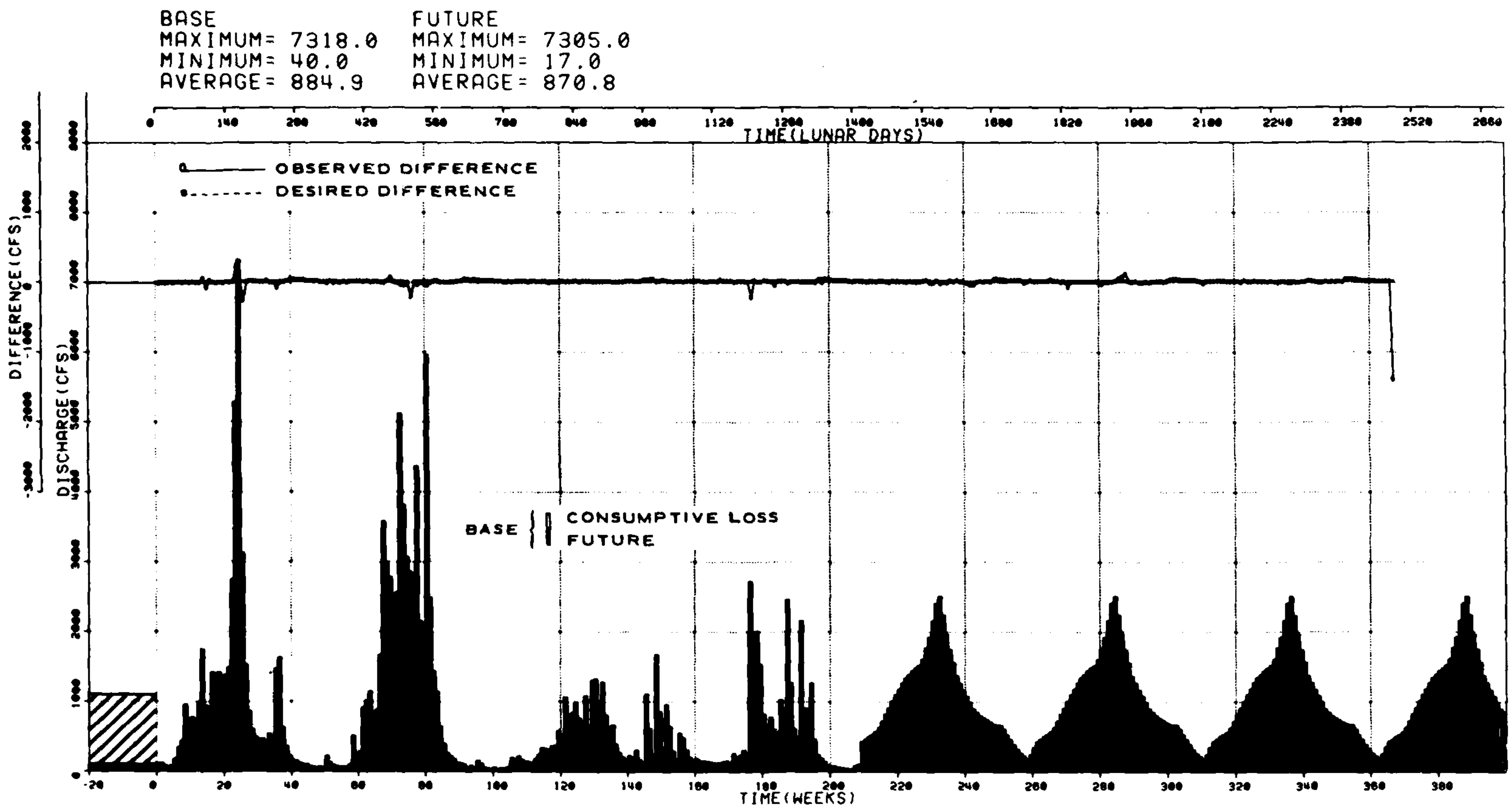
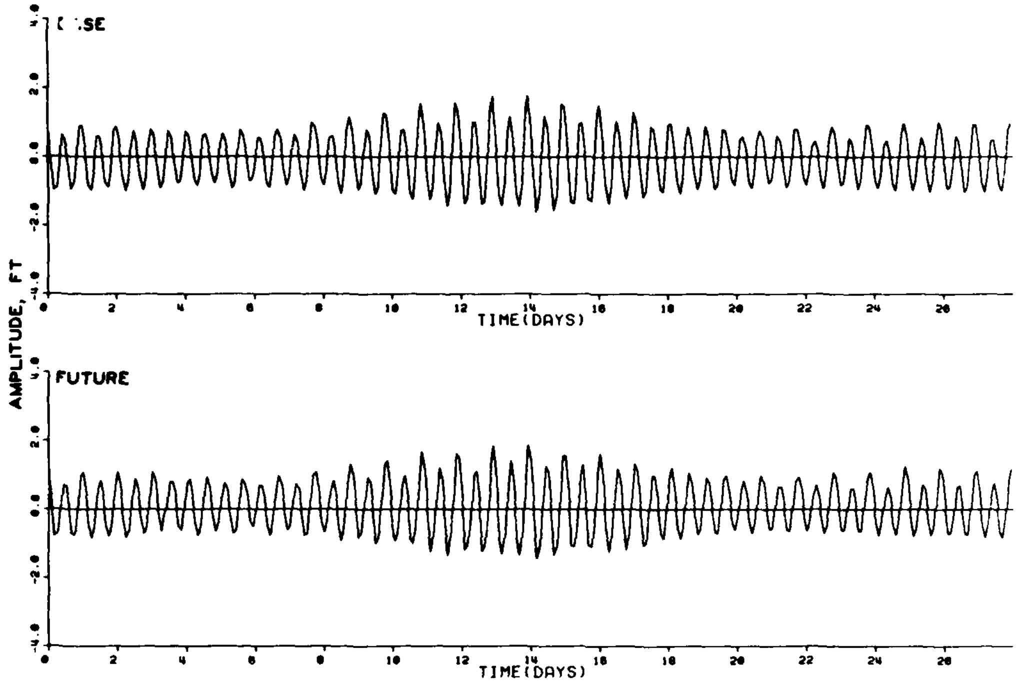
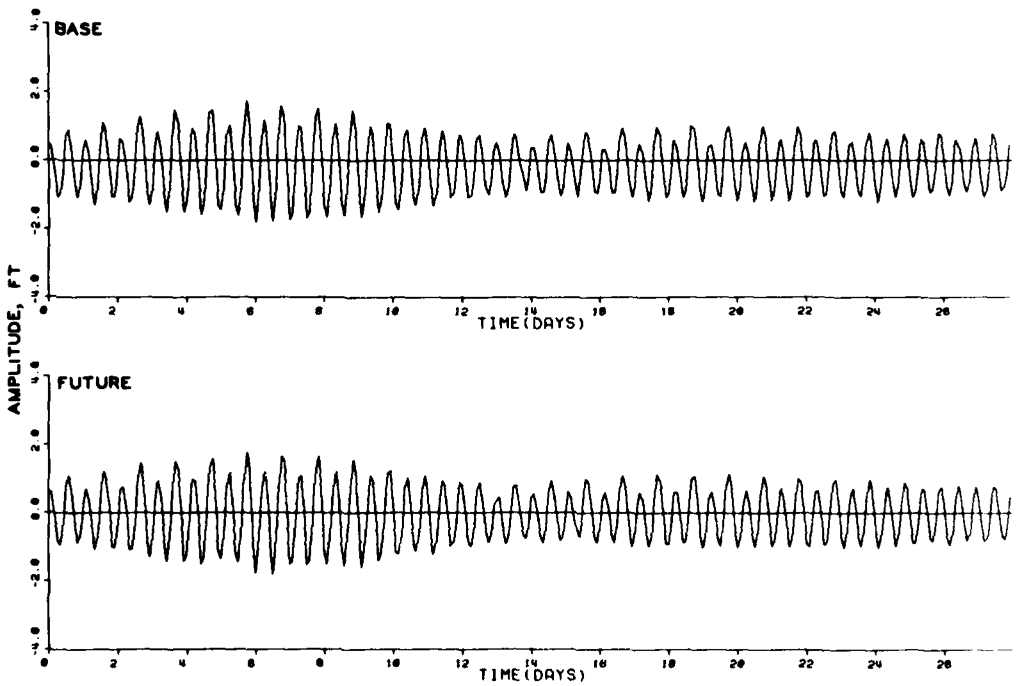


Plate 22. Discharge hydrograph, inflow 21, Pocomoke River

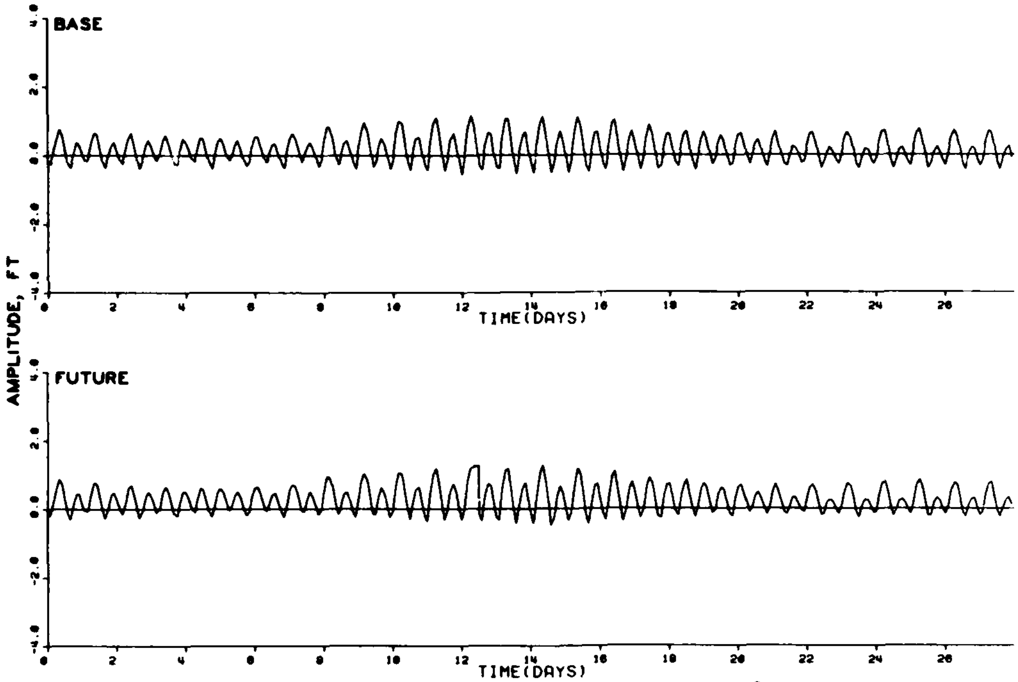


HIGH-FLOW PERIOD (WEEKS 24-27)

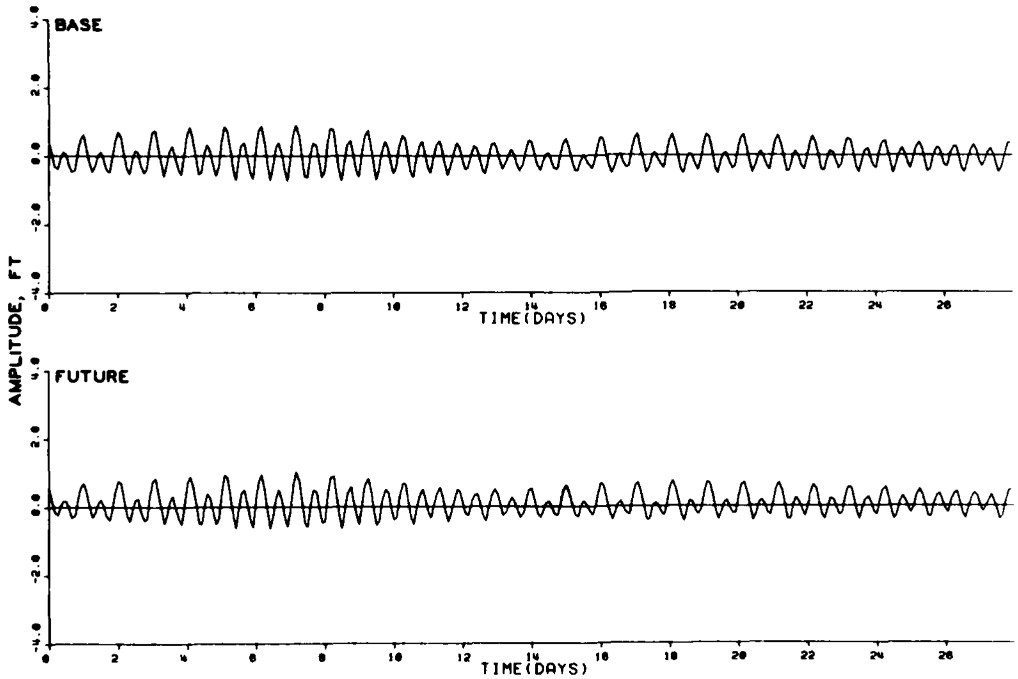


LOW-FLOW PERIOD (WEEKS 54-57)

Plate 23. Time-history, water-level detector 69



HIGH-FLOW PERIOD (WEEKS 24-27)



LOW-FLOW PERIOD (WEEKS 54-57)

Plate 24. Time-history, water-level detector 78

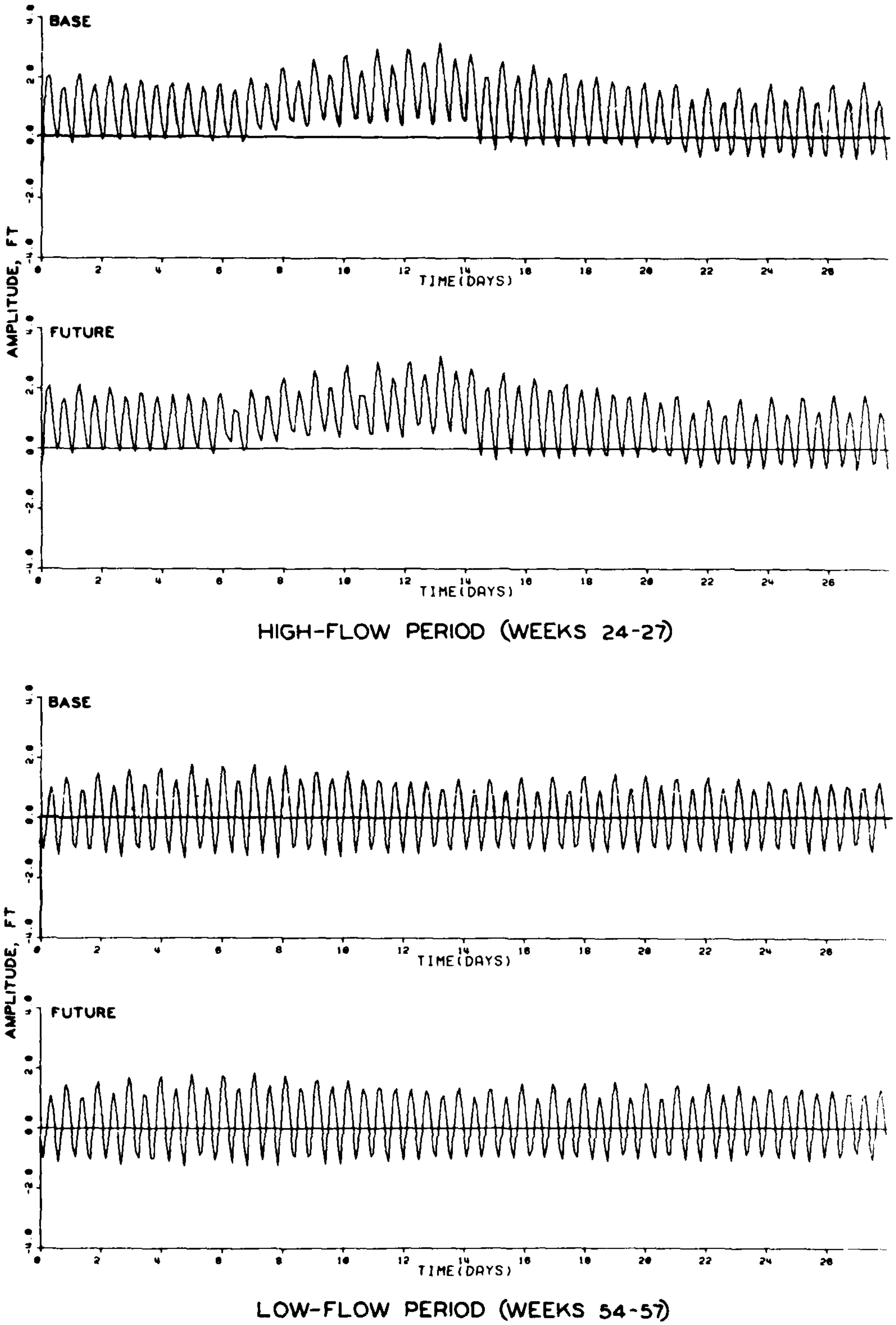
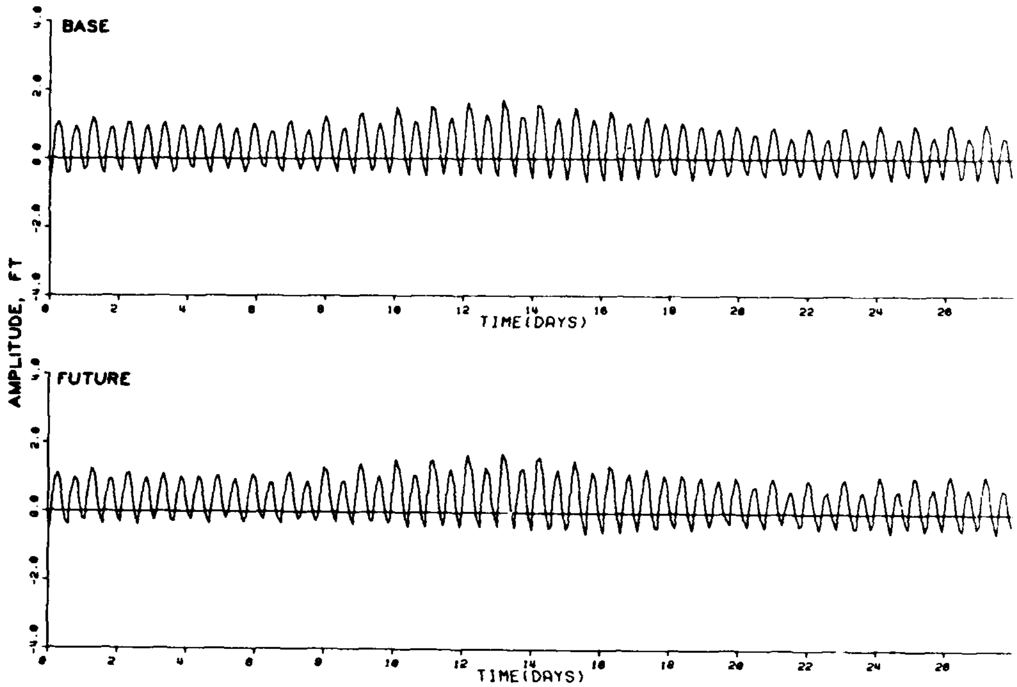
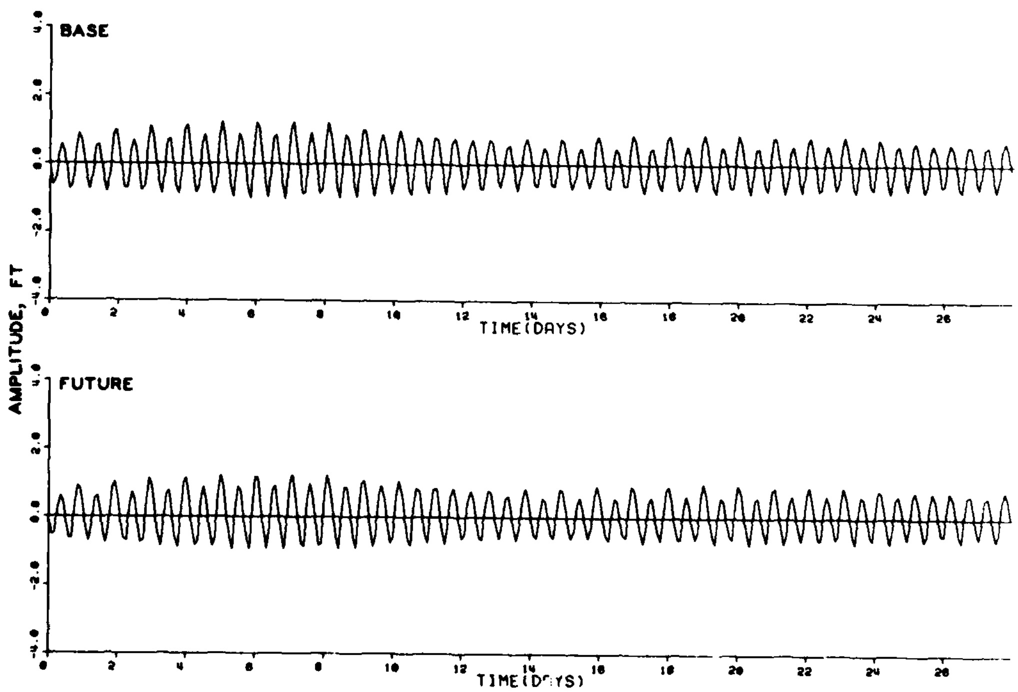


Plate 25. Time-history, water-level detector 71

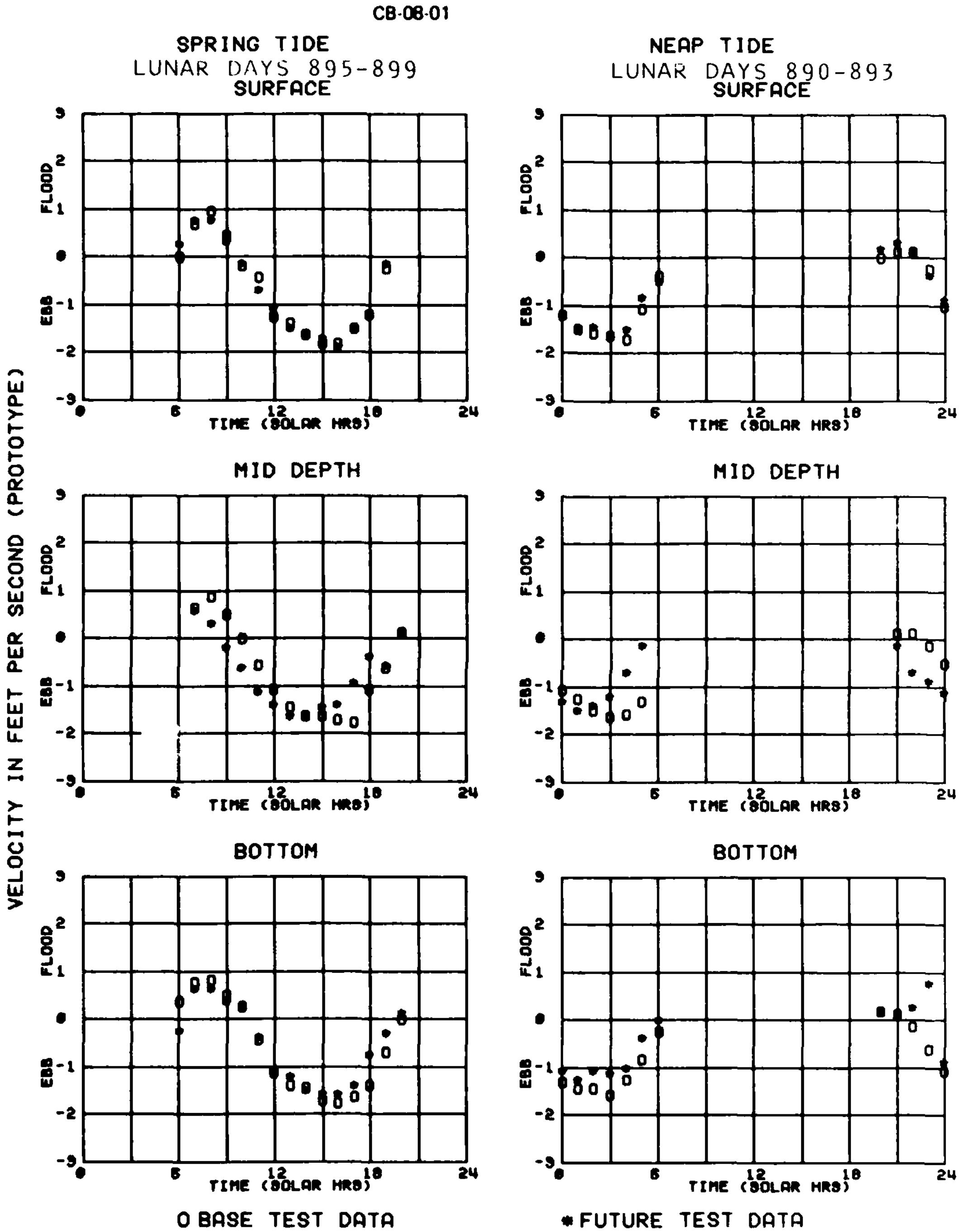


HIGH-FLOW PERIOD (WEEKS 24-27)



LOW-FLOW PERIOD (WEEKS 54-57)

Plate 26. Time-history, water-level detector 76



LFIT VELOCITY COMPARISON: APRIL 65

Plate 27. Velocity time-history, sta CB-08-01, Apr 1965

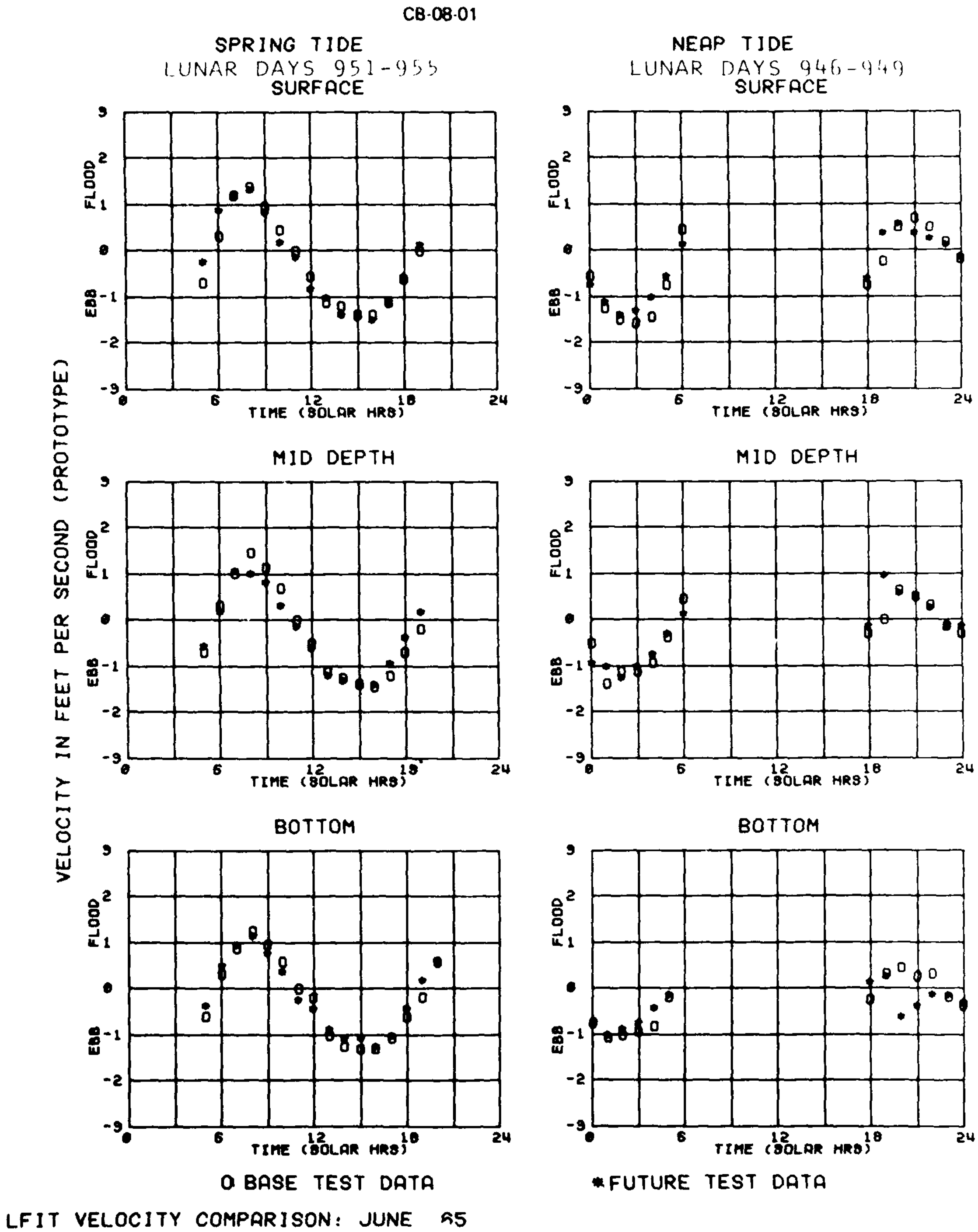


Plate 28. Velocity time-history, sta CB-08-01, Jun 1965

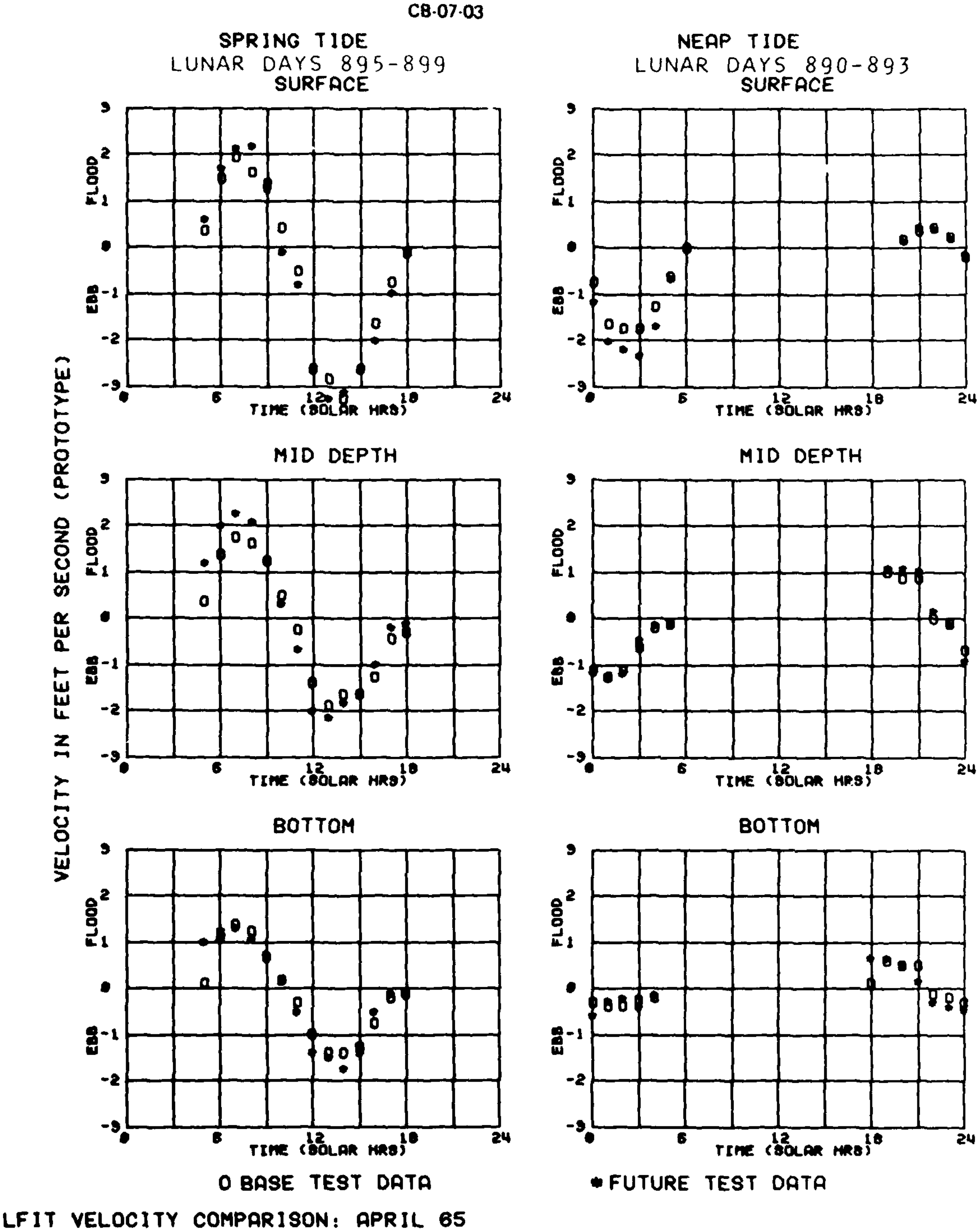


Plate 29. Velocity time-history, sta CB-07-03, Apr 1965

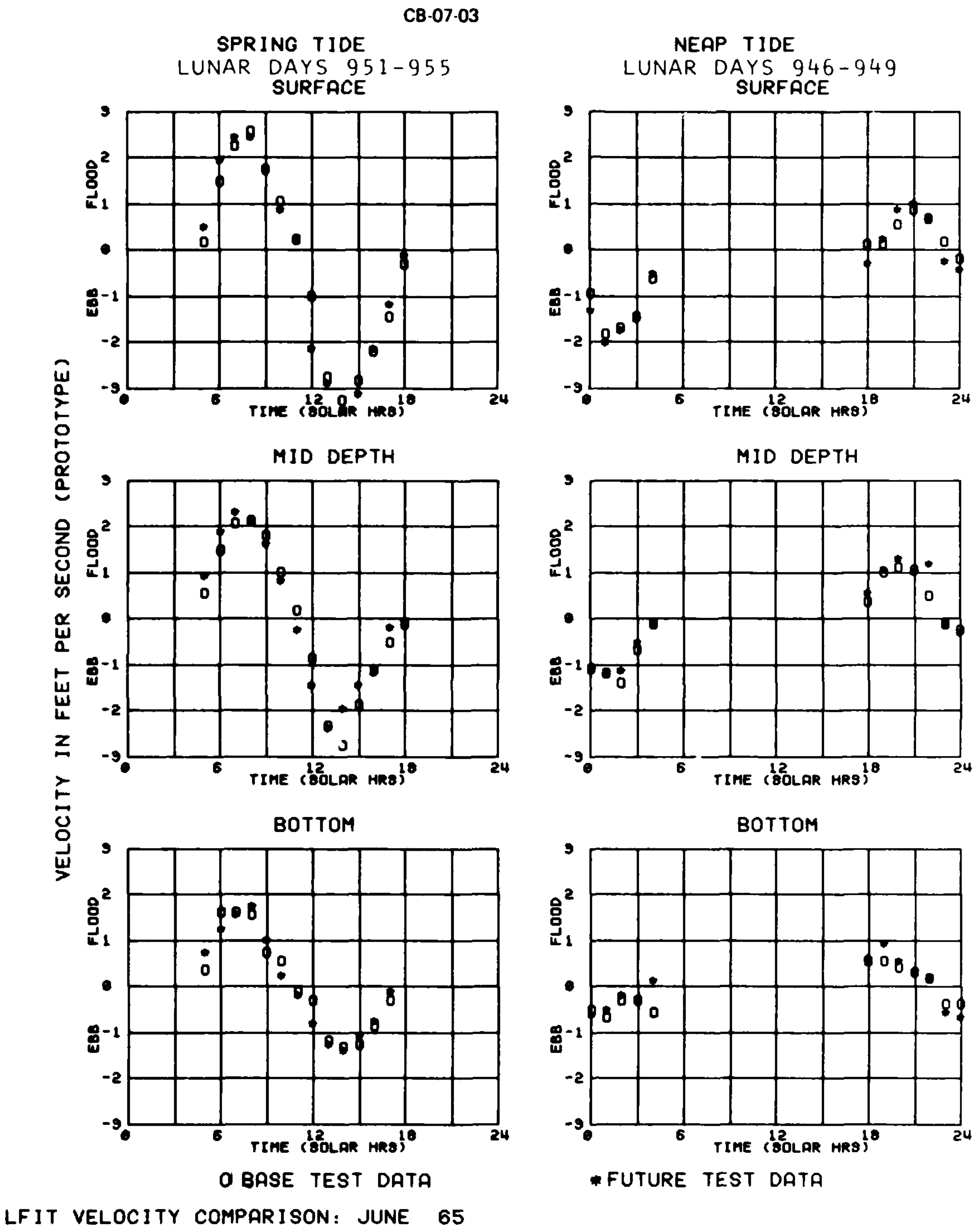


Plate 30. Velocity time-history, sta CB-07-03, Jun 1965

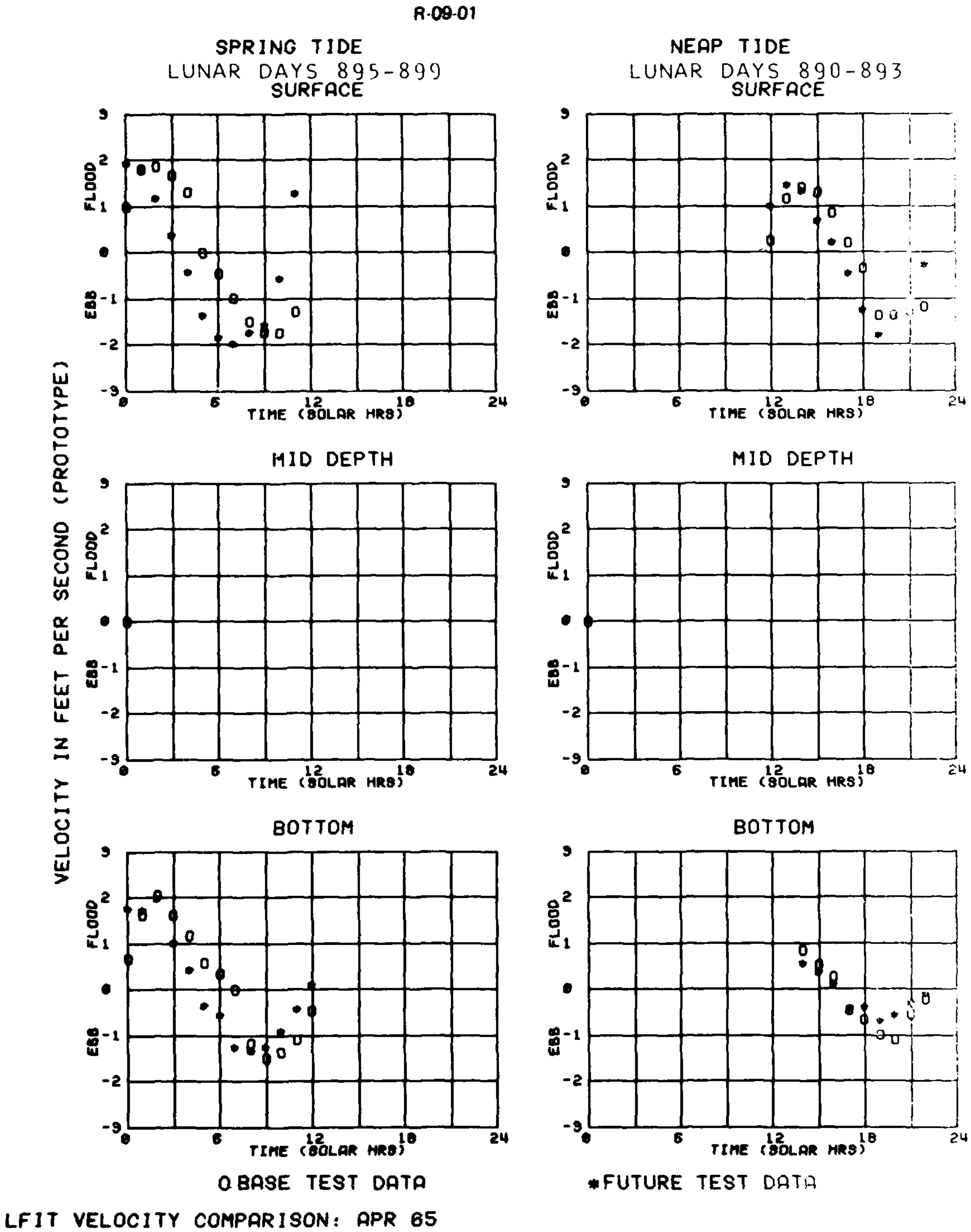


Plate 31. Velocity time-history, sta R-09-01, Apr 1965

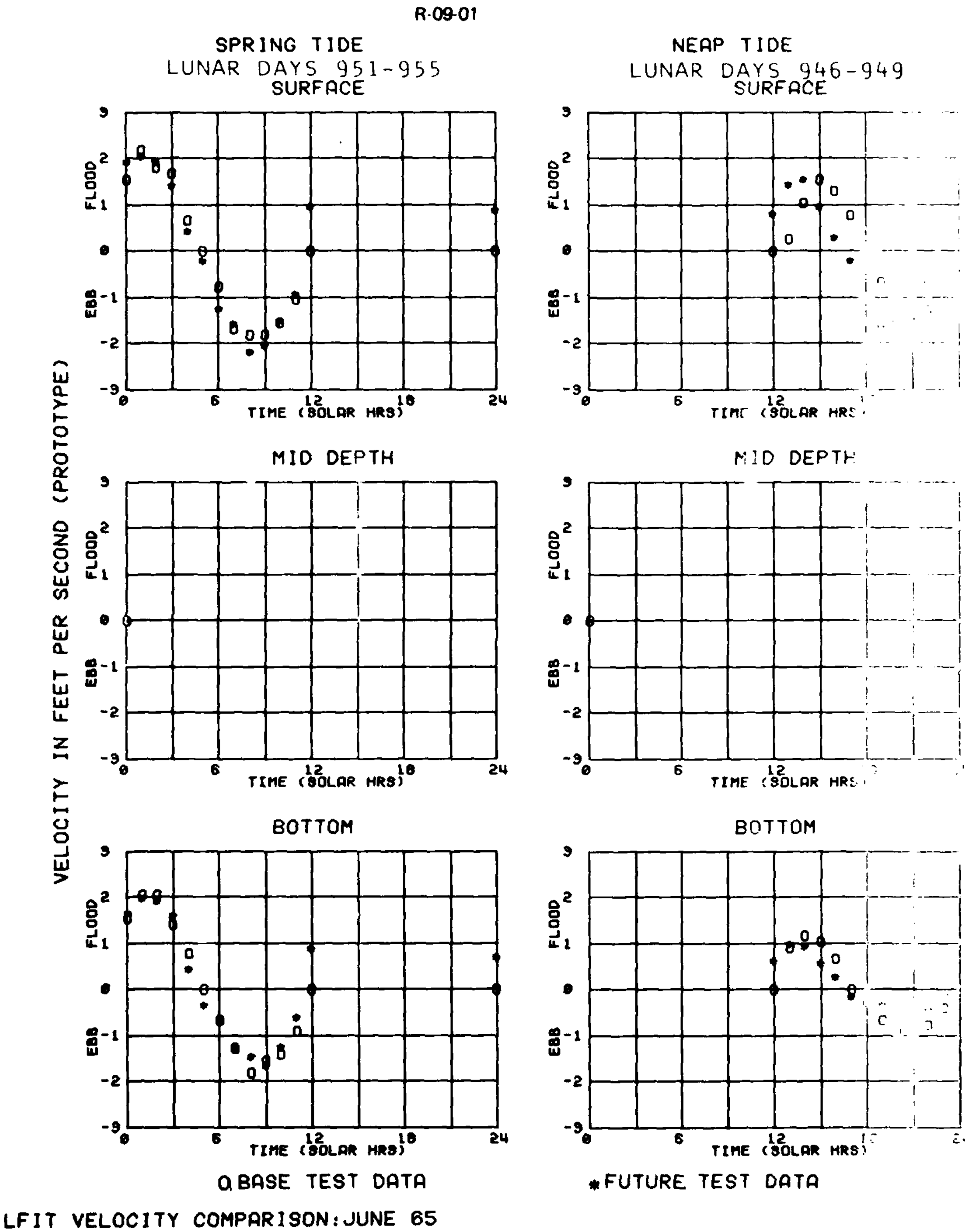


Plate 32. Velocity time-history, sta R-09-01, Jun 1965

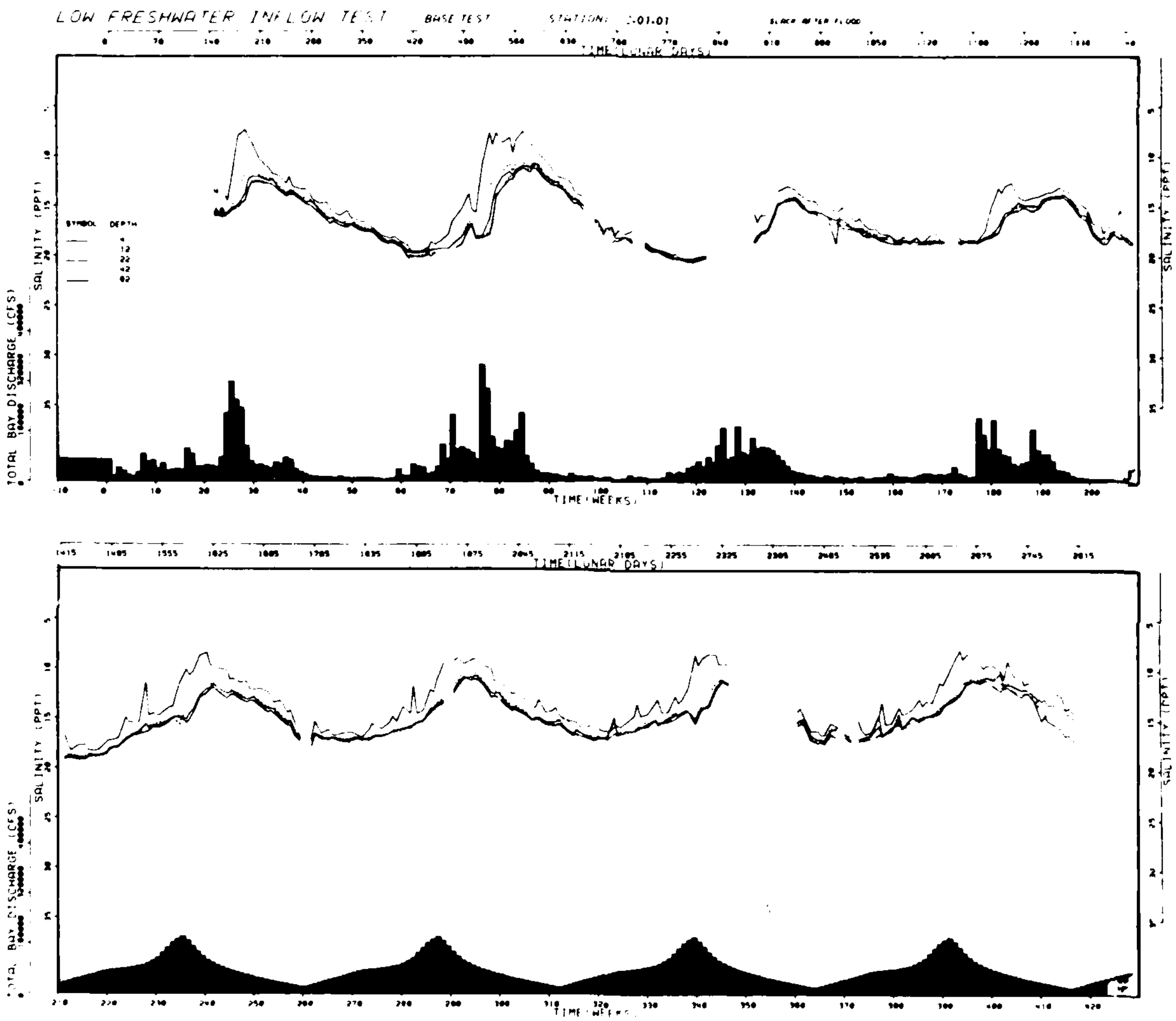


Plate 33. Salinity time-history, Base Test, sta C-01-01

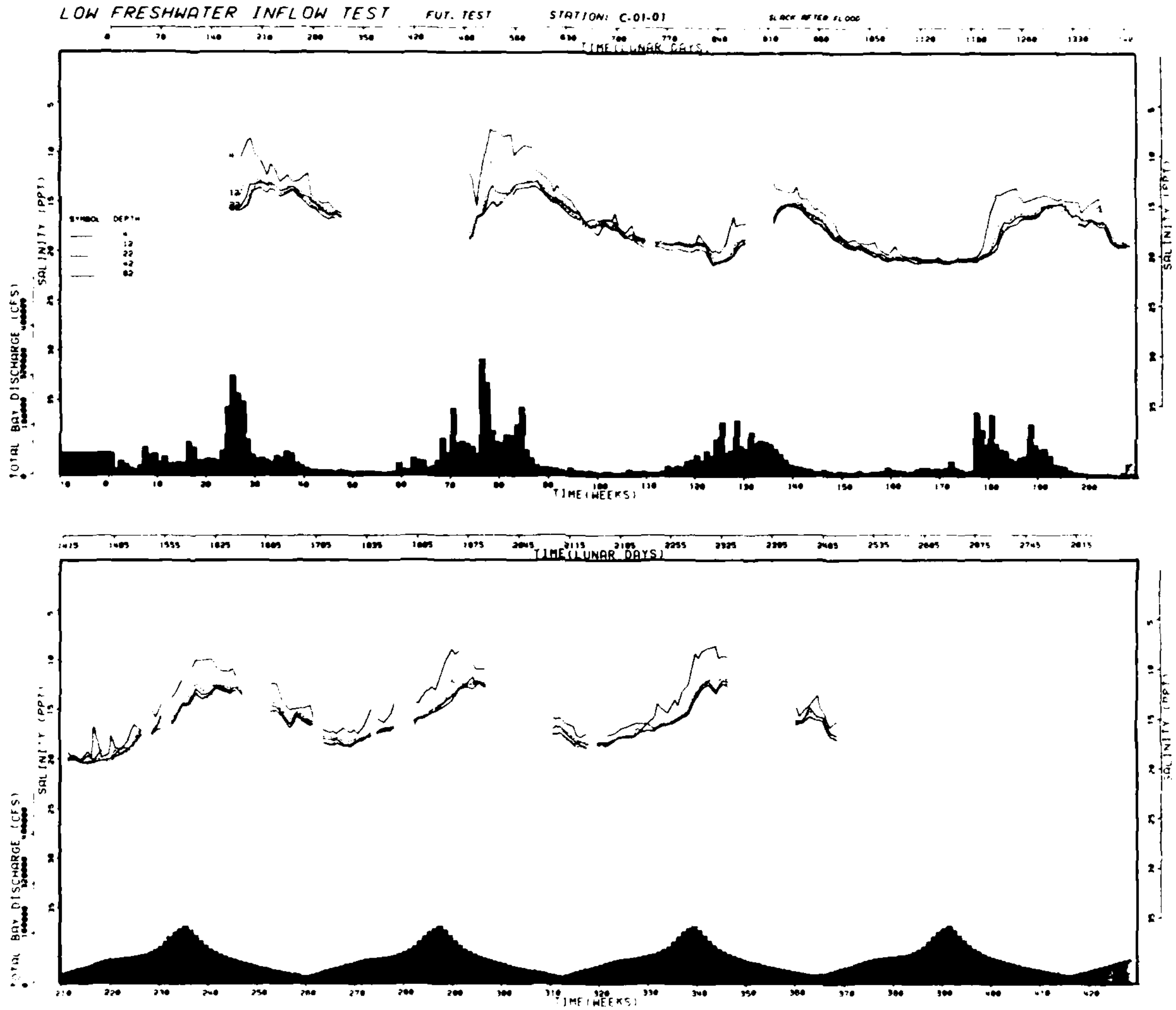


Plate 34. Salinity time-history, Future Test, sta C-01-01

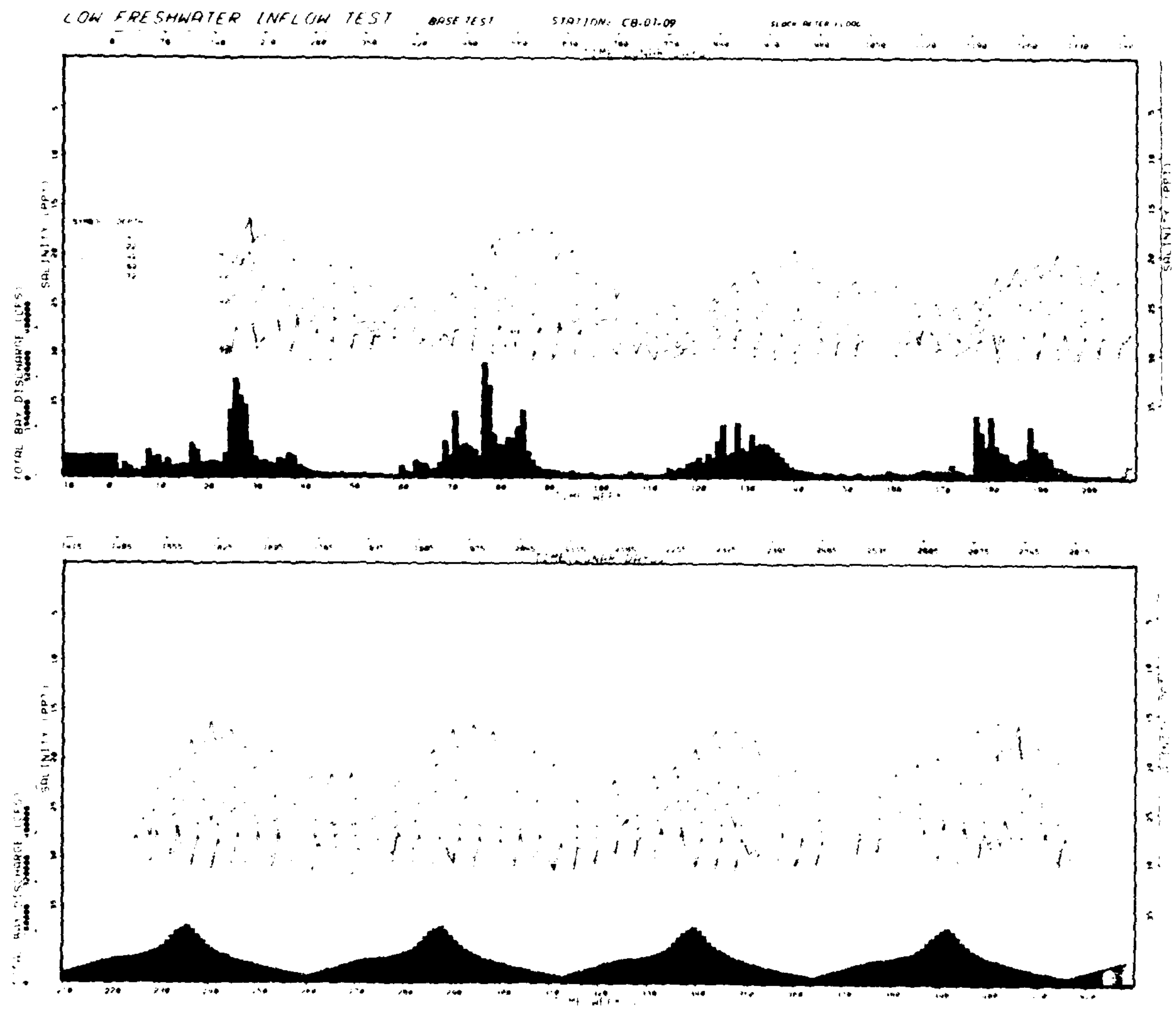


Plate 35. Salinity time-history, Base Test, sta C-01-09

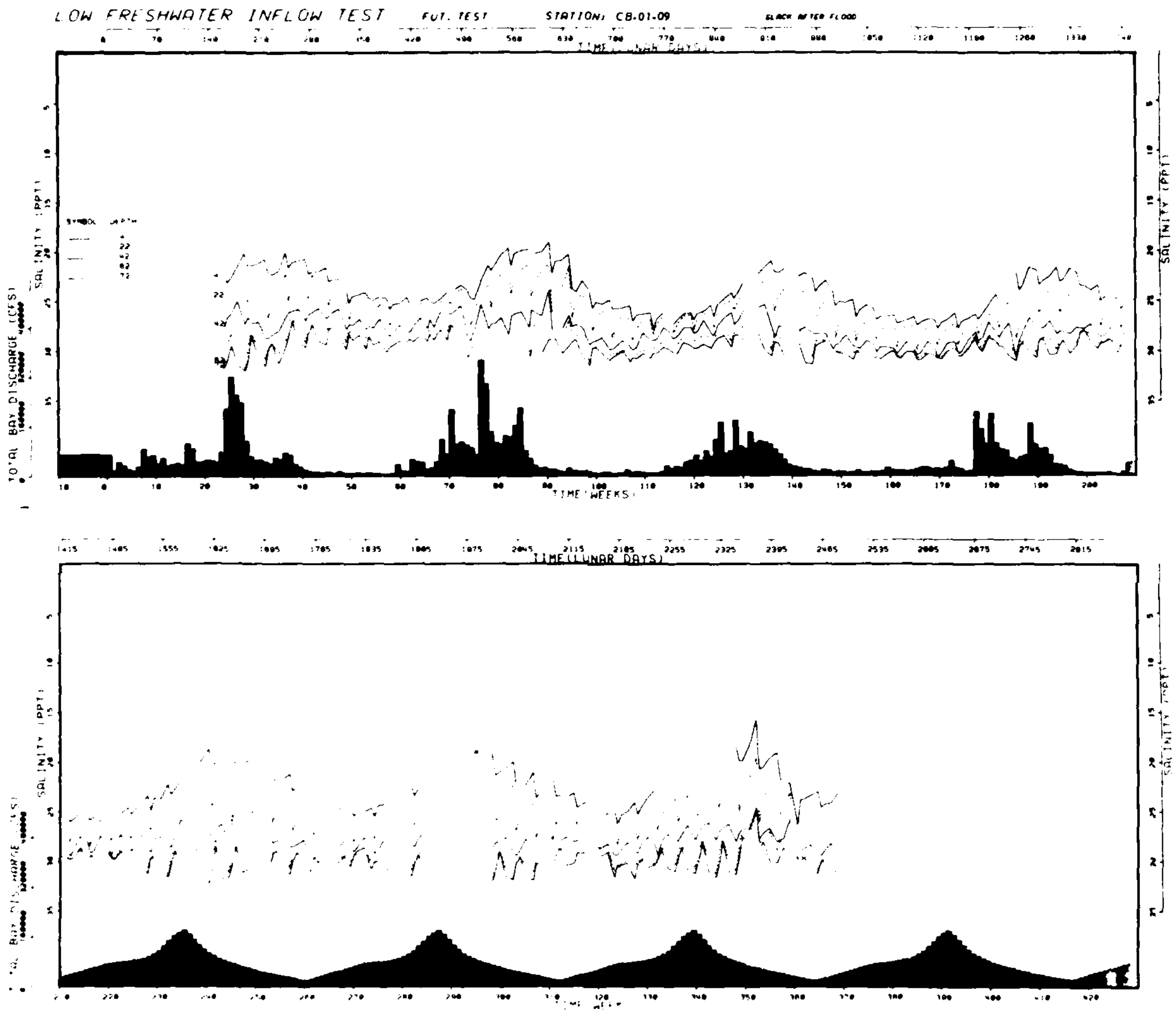


Plate 36. Salinity time-history, Future Test, sta C-01-09

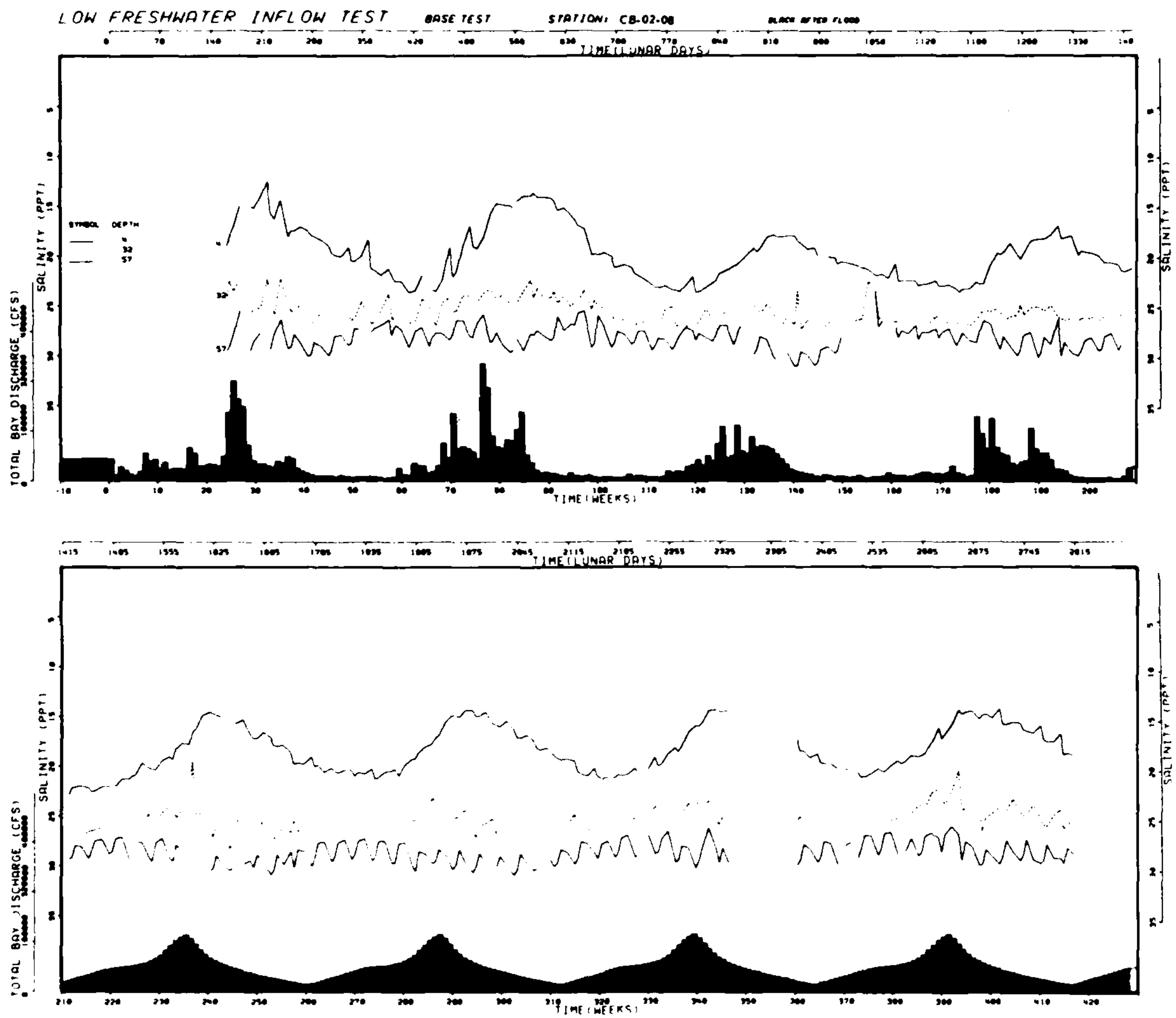


Plate 37. Salinity time-history, Base Test, sta CB-02-08

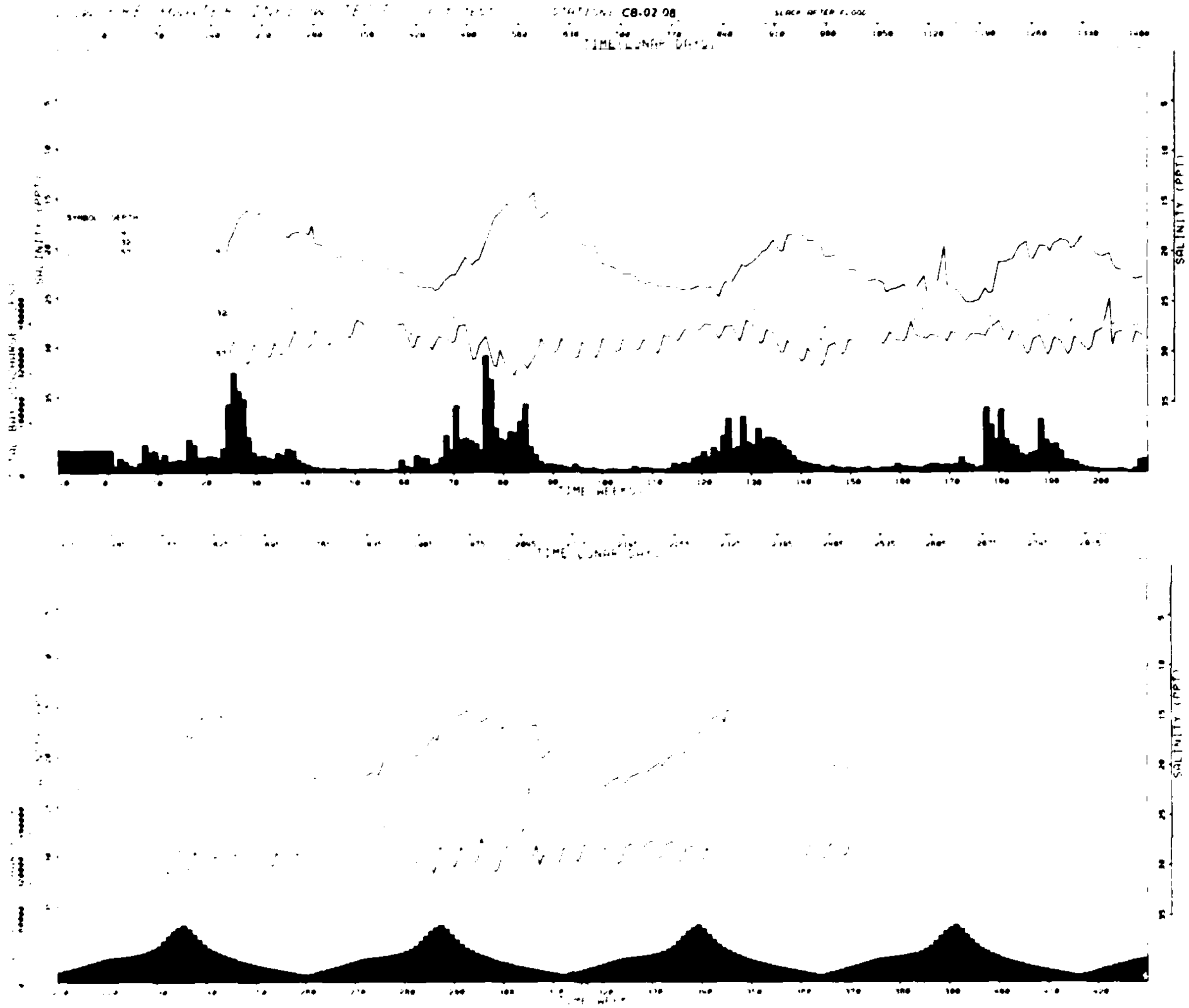


Plate 38. Salinity time-history, Future Test, sta CB-02-08

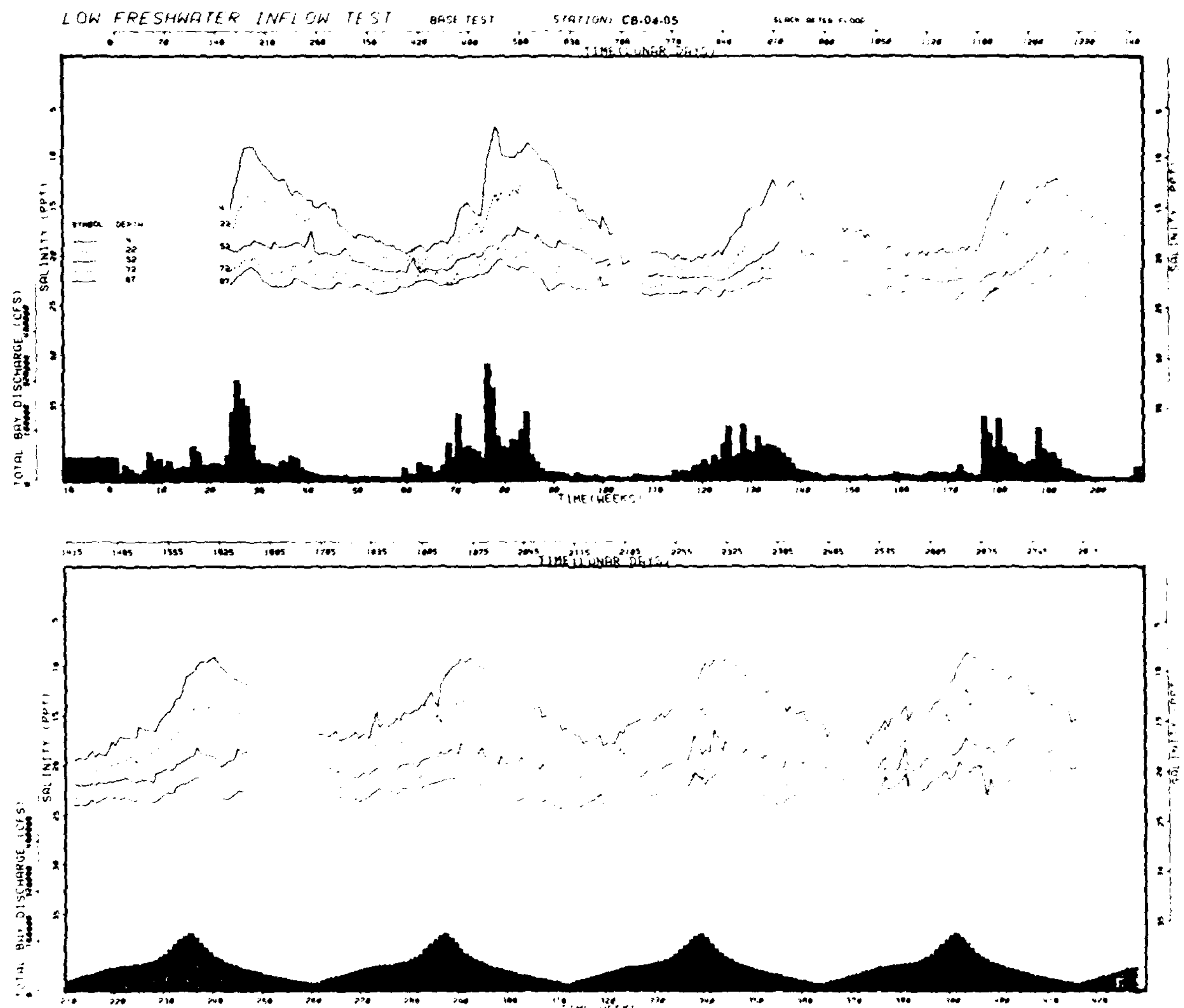


Plate 39. Salinity time-history, Base Test, sta CB-04-05

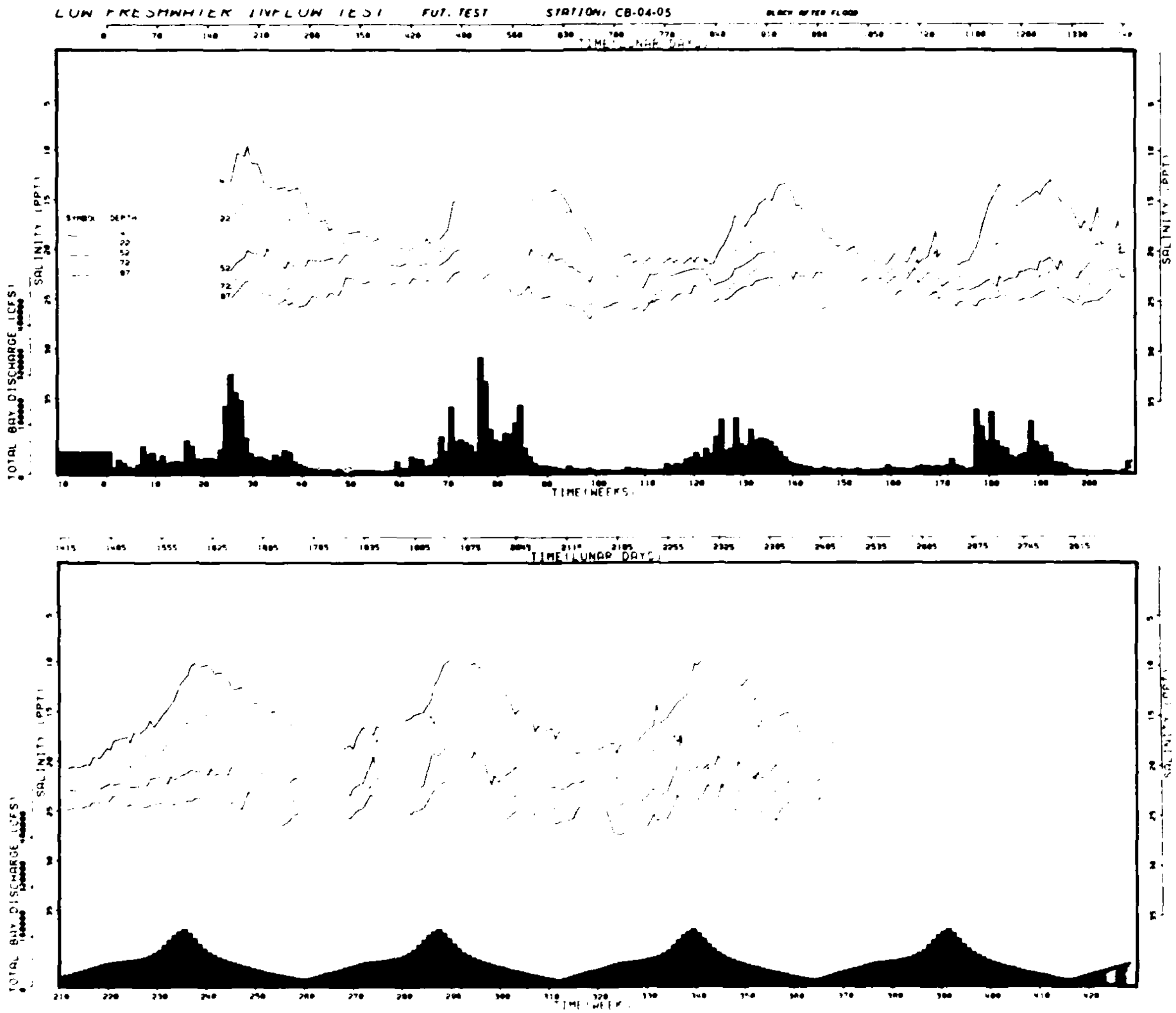


Plate 40. Salinity time-history, Future Test, sta CB-04-05

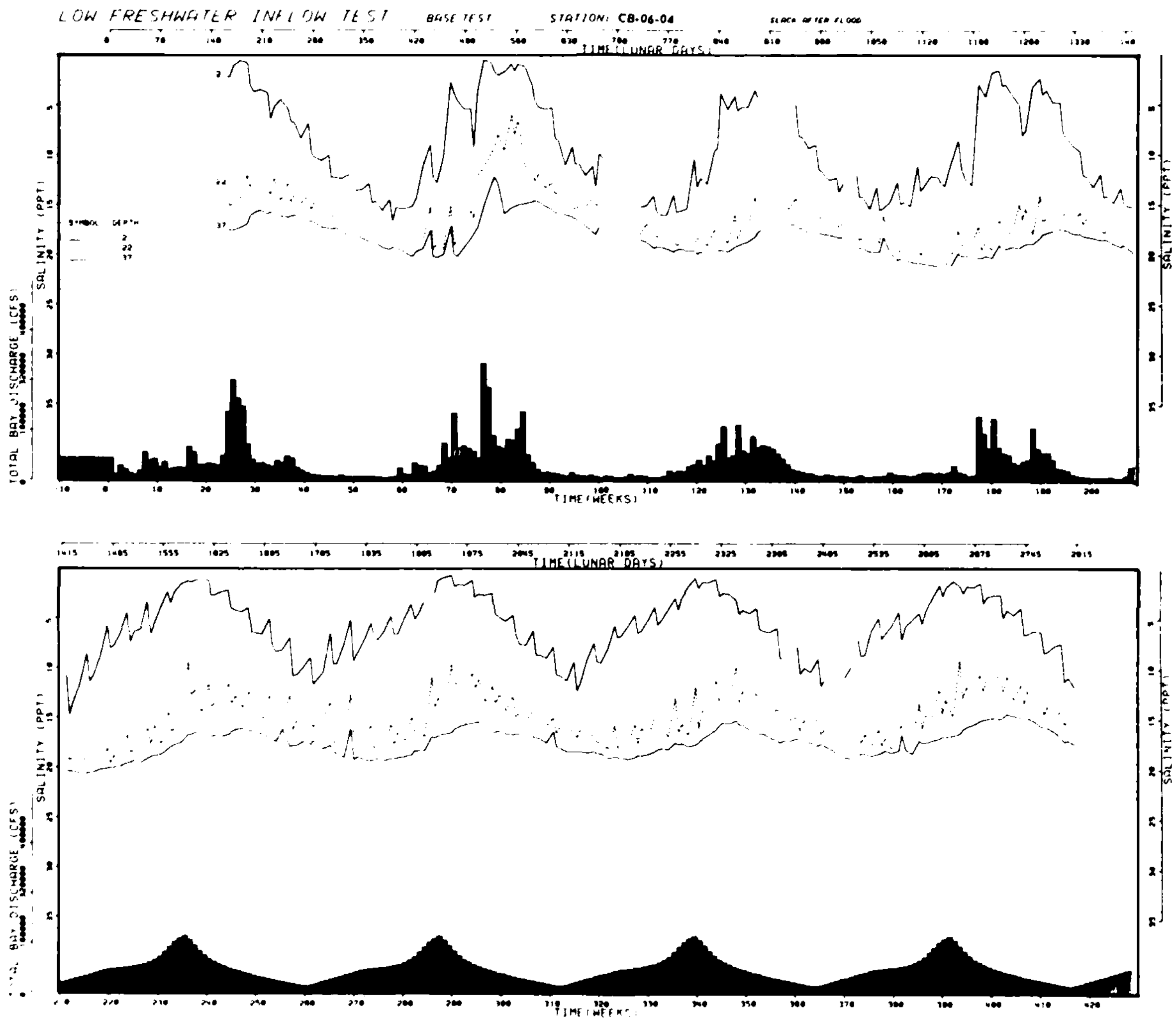


Plate 41. Salinity time-history, Base Test, sta CB-06-04

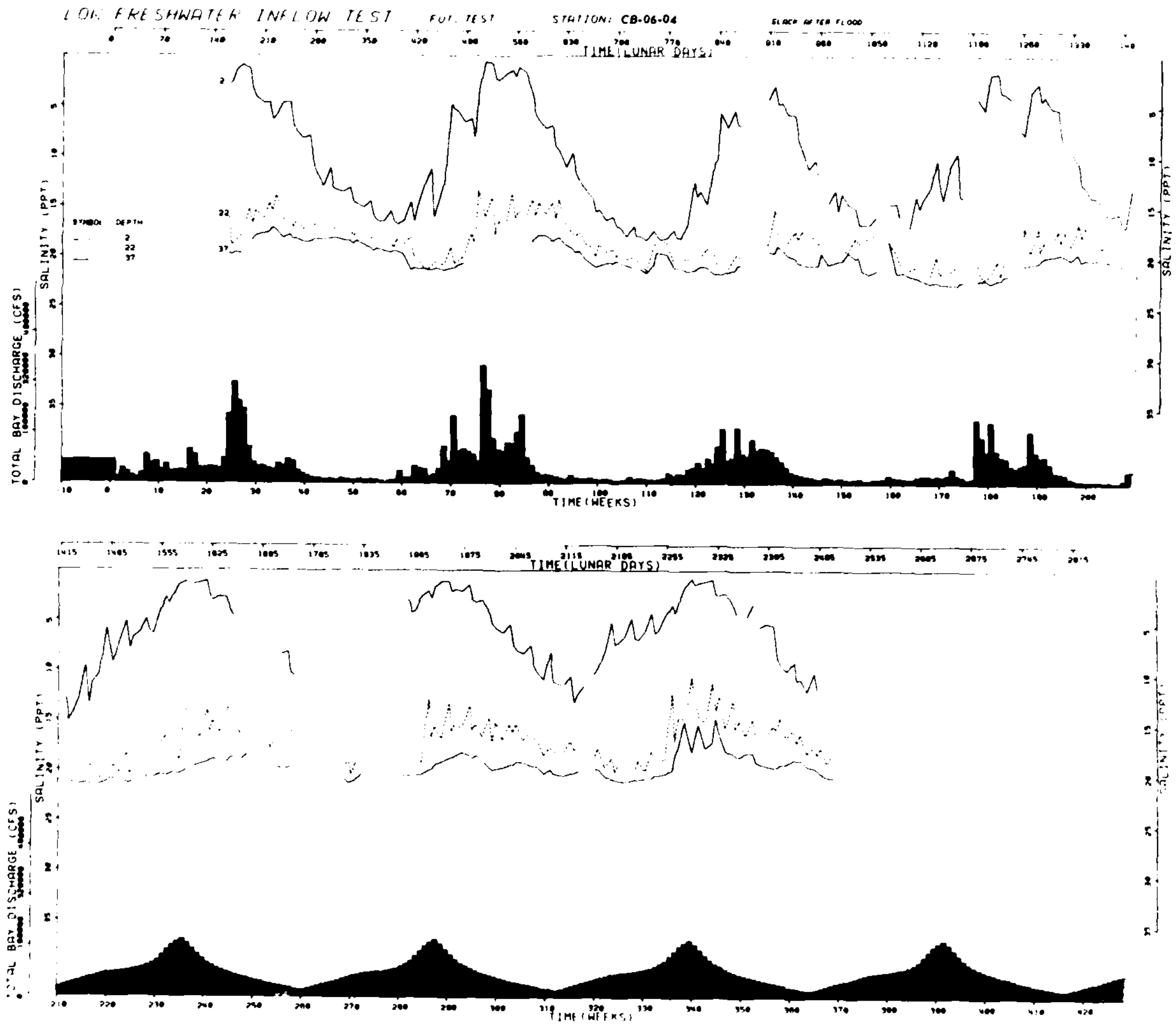


Plate 42. Salinity time-history, Future Test, sta CB-06-04

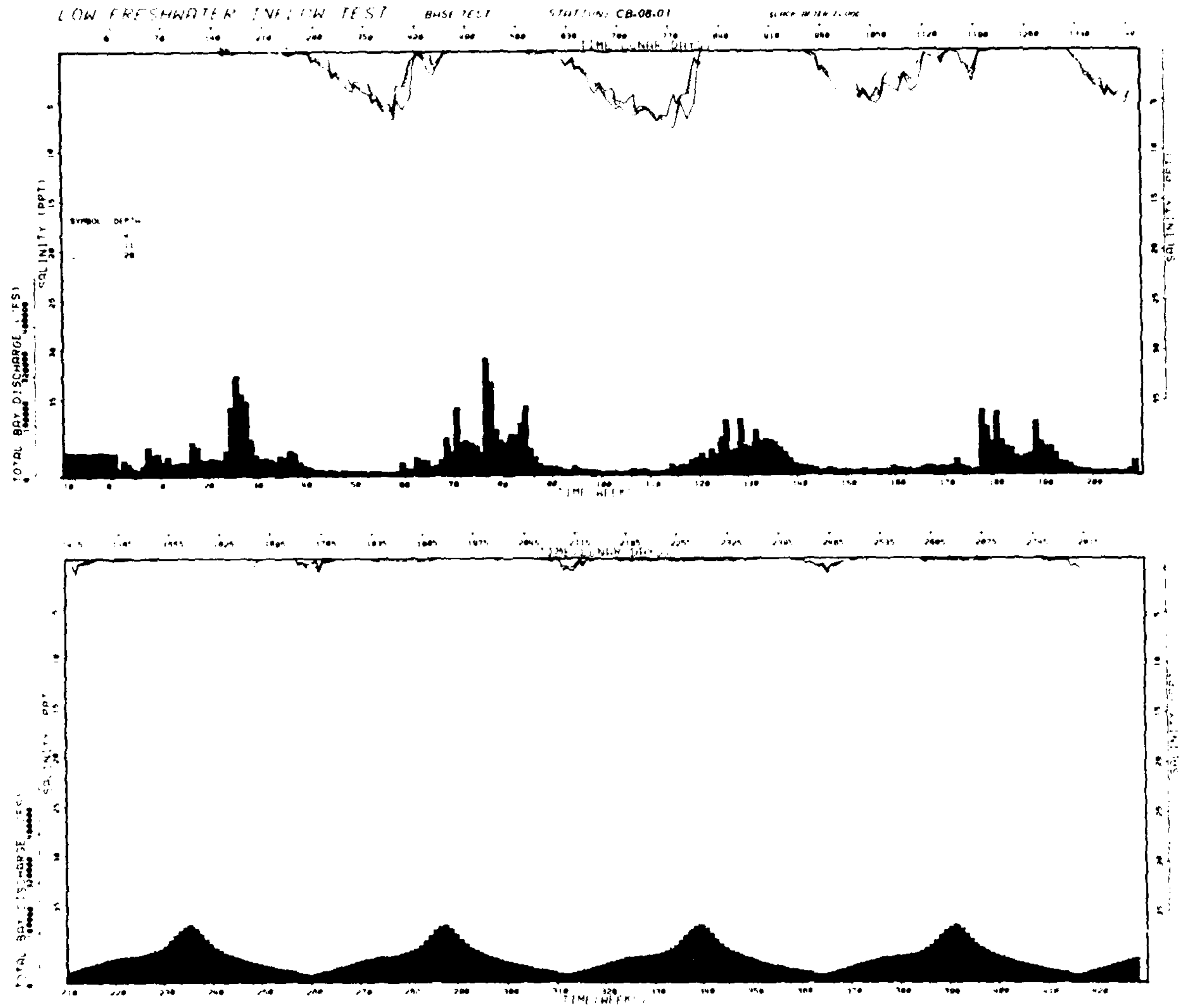


Plate 43. Salinity time-history, Base Test, sta CB-08-01

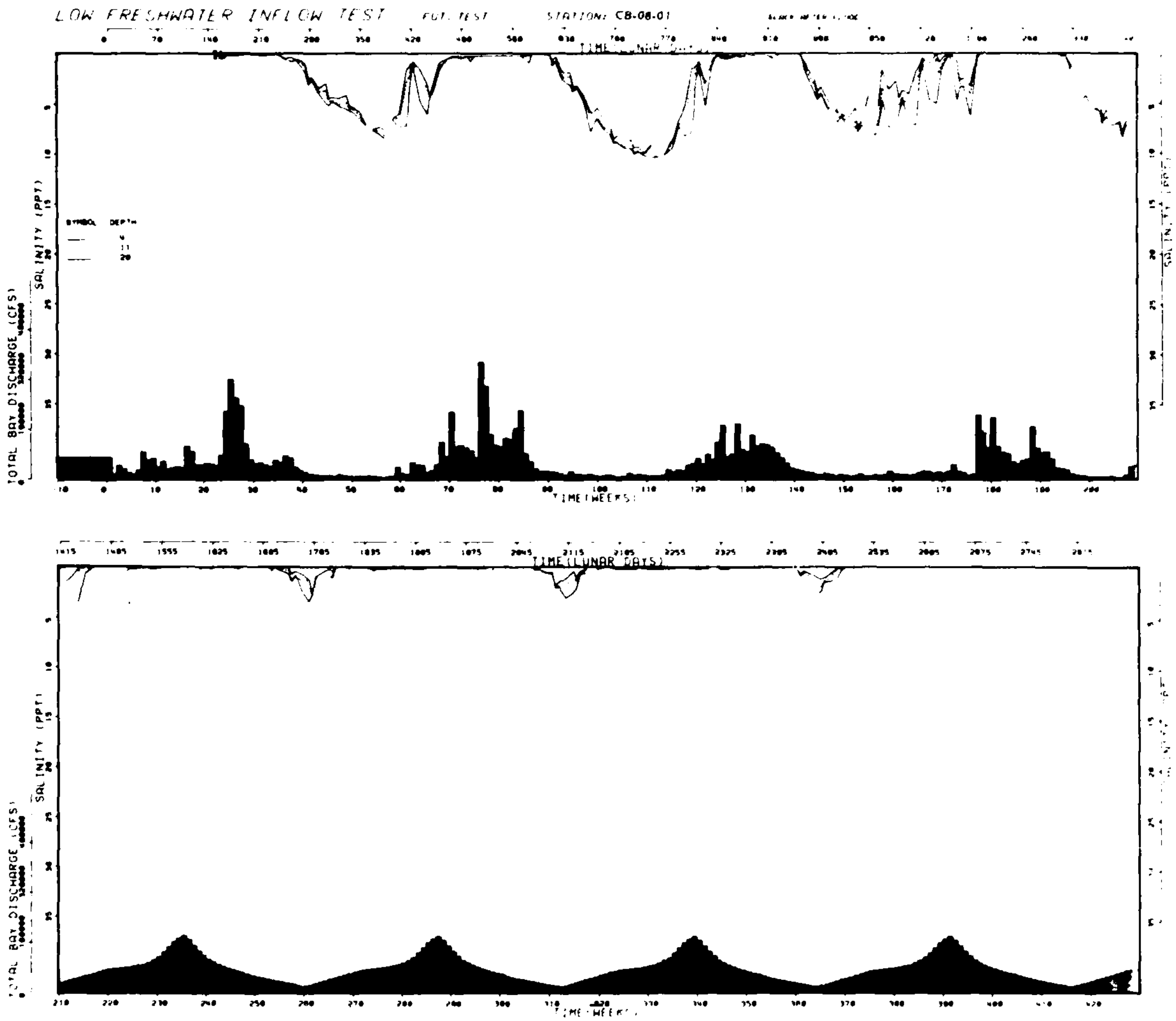


Plate 44. Salinity time-history, Future Test, sta CB-08-01

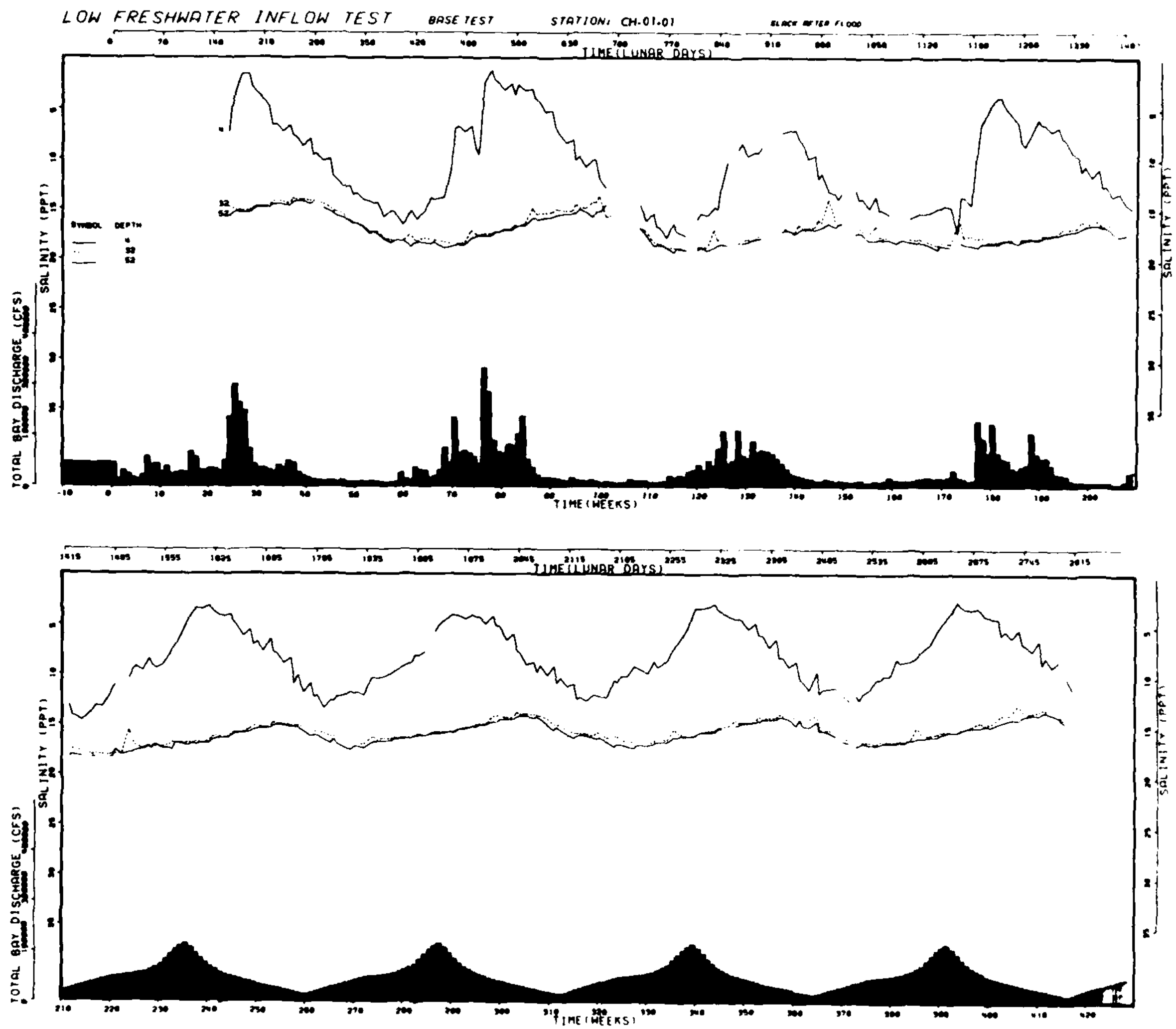


Plate 45. Salinity time-history, Base Test, sta CH-01-01

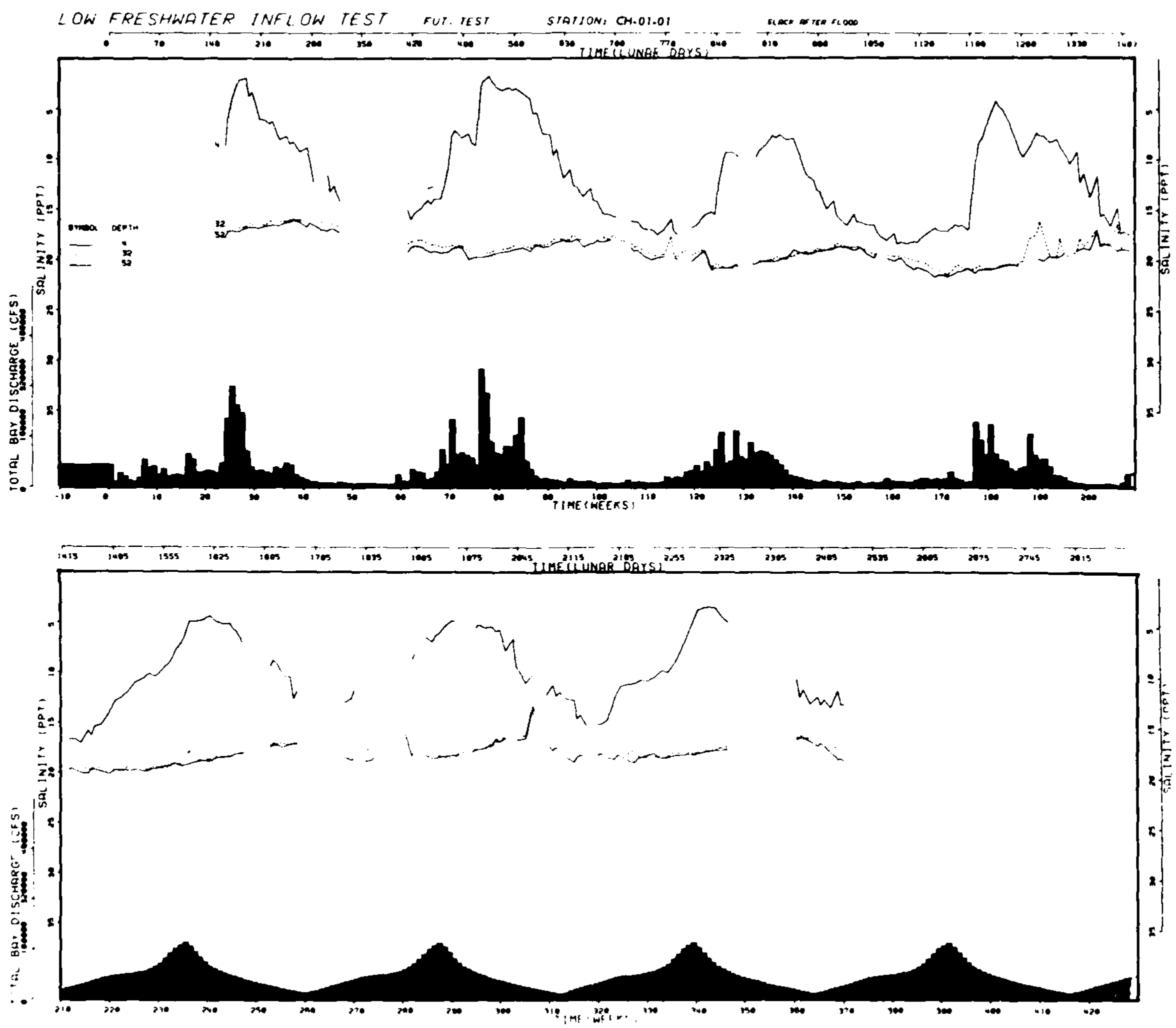


Plate 46. Salinity time-history, Future Test, sta CH-01-01

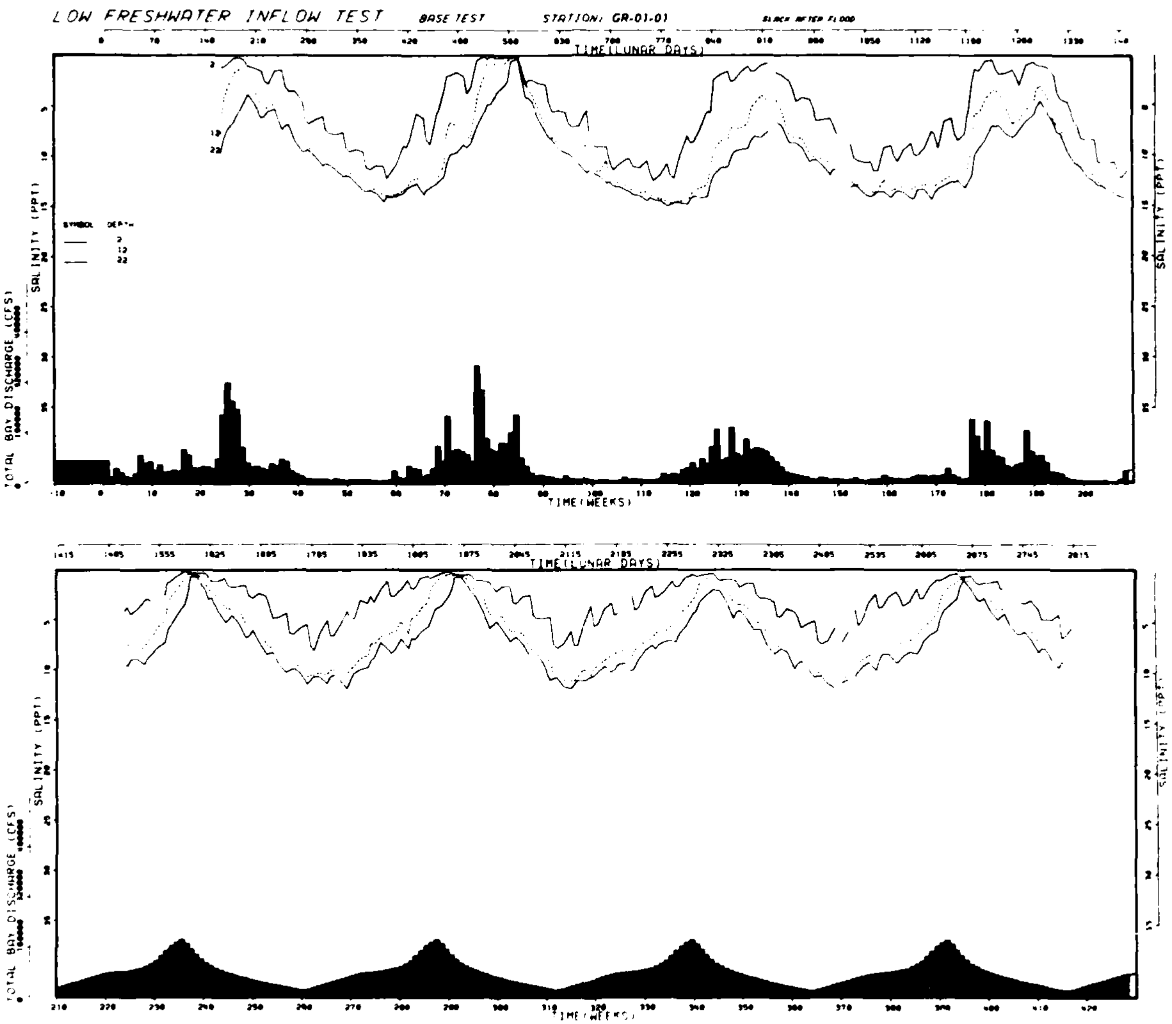


Plate 47. Salinity time-history, Base Test, sta GR-01-01

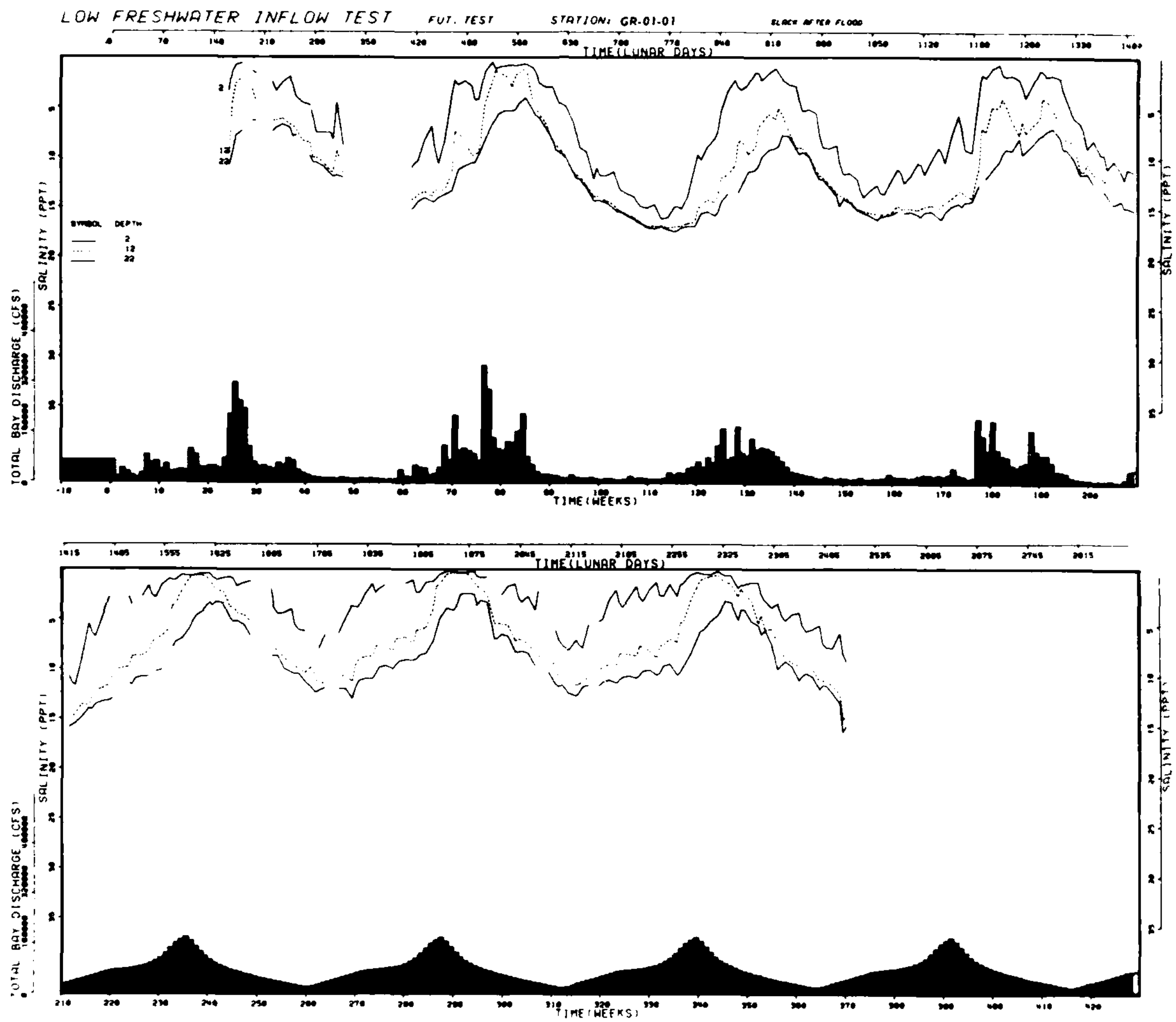


Plate 48. Salinity time-history, Future Test, sta GR-01-01

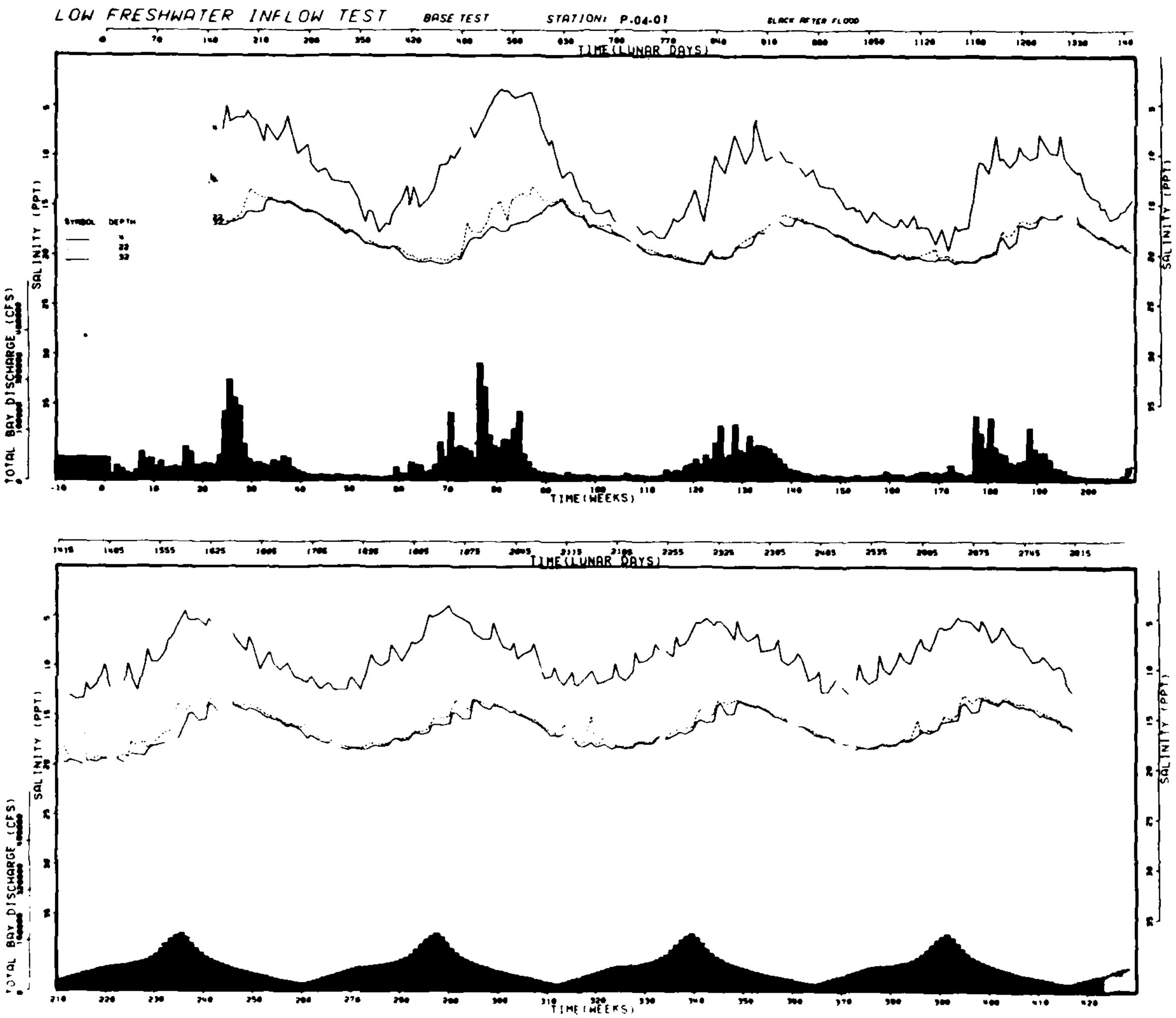


Plate 49. Salinity time-history, Base Test, sta P-04-01

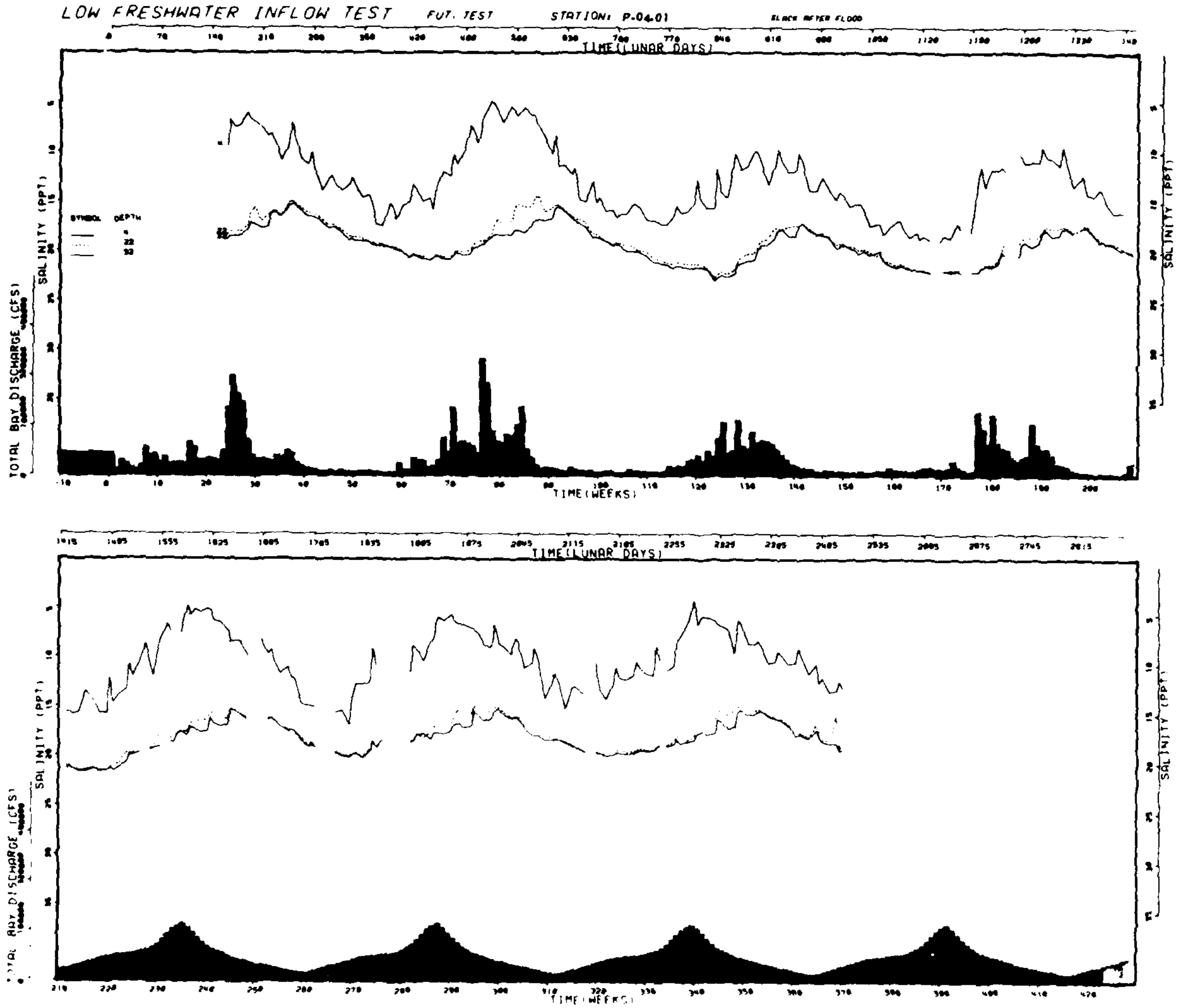


Plate 50. Salinity time-history, Future Test, sta P-04-01

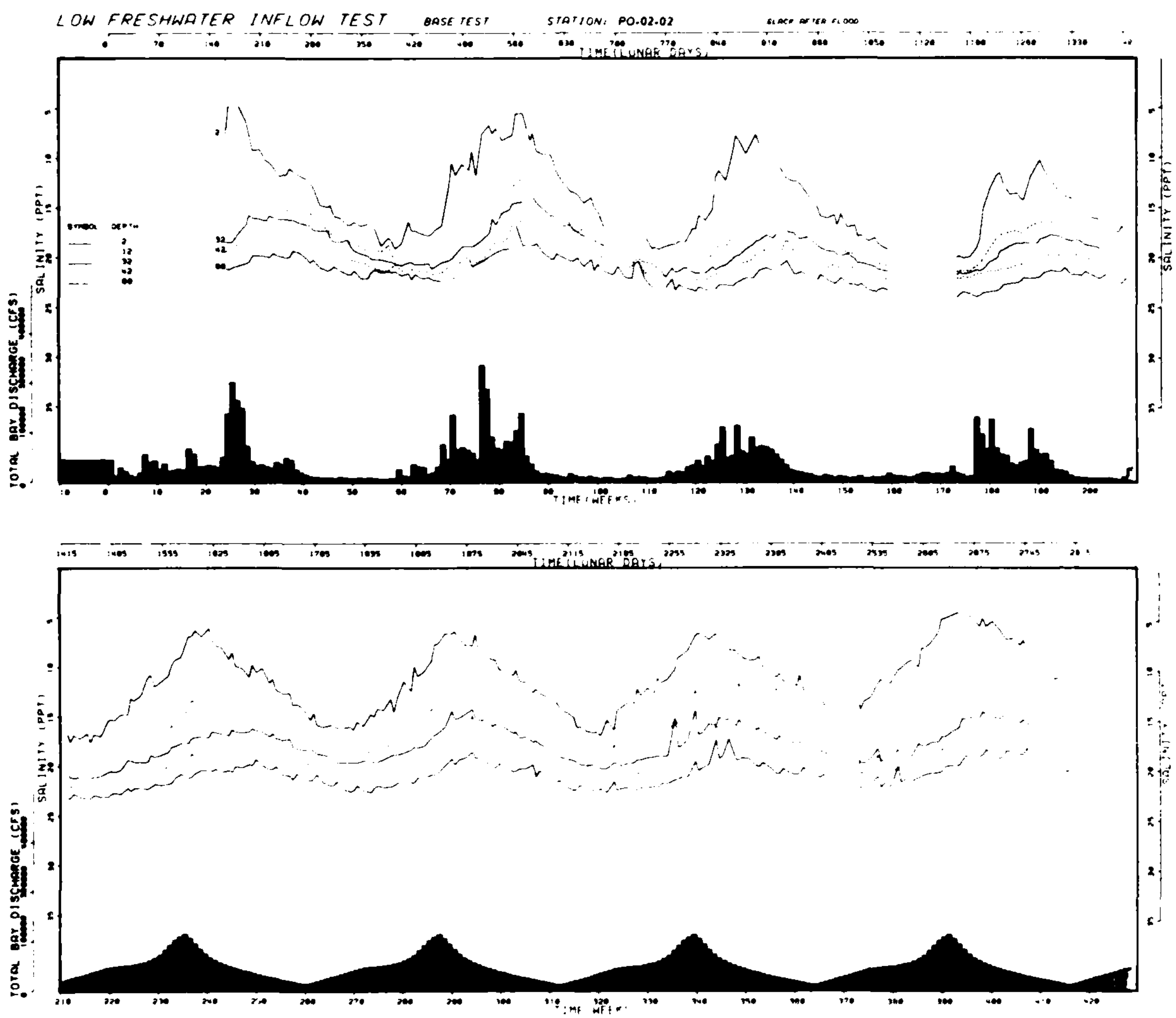


Plate 51. Salinity time-history, Base Test, sta PO-02-02

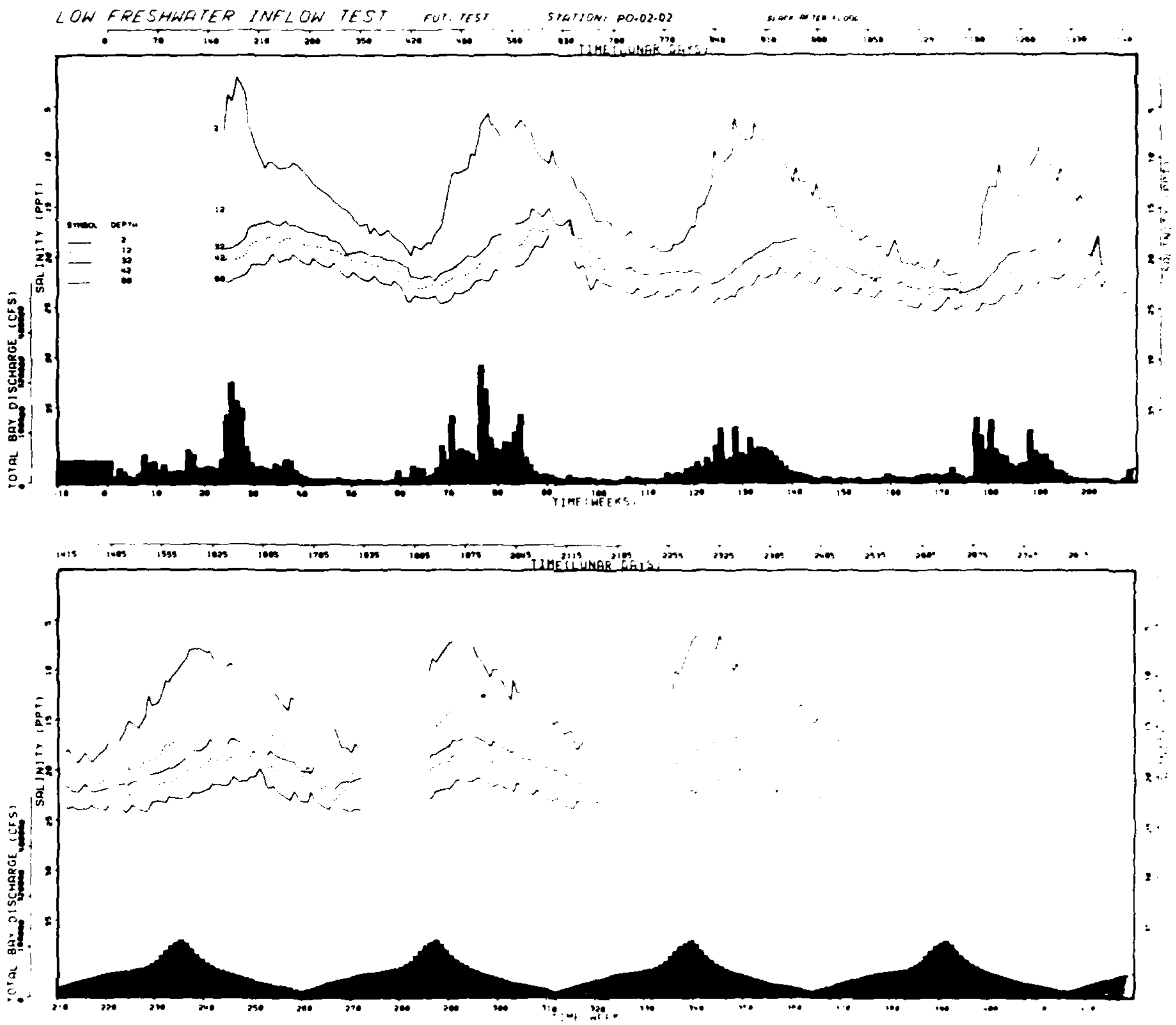


Plate 52. Salinity time-history, Future Test, sta PO-02-02

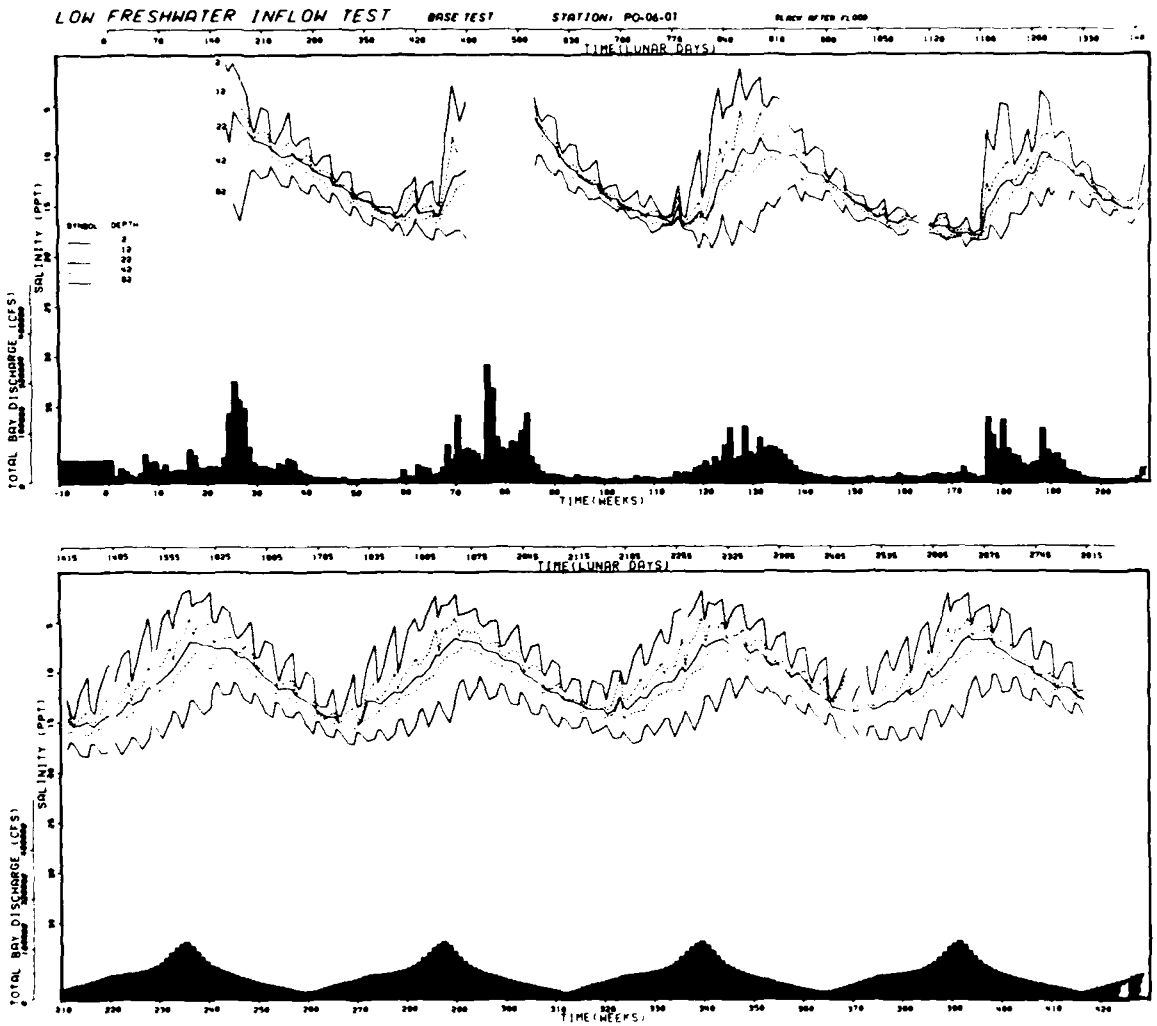


Plate 53. Salinity time-history, Base Test, sta PO-06-01

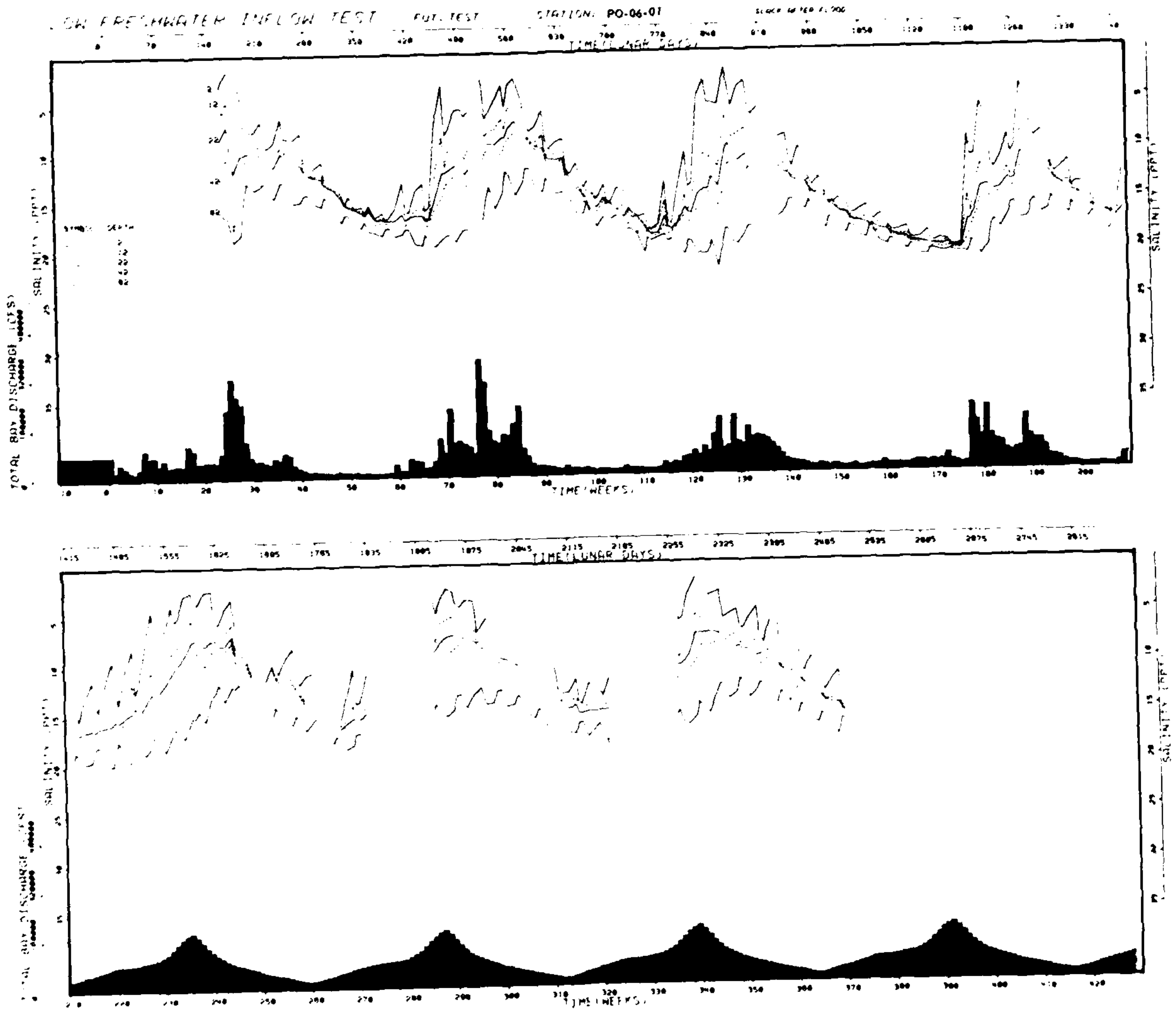


Plate 54. Salinity time-history, Future Test, sta PO-06-01

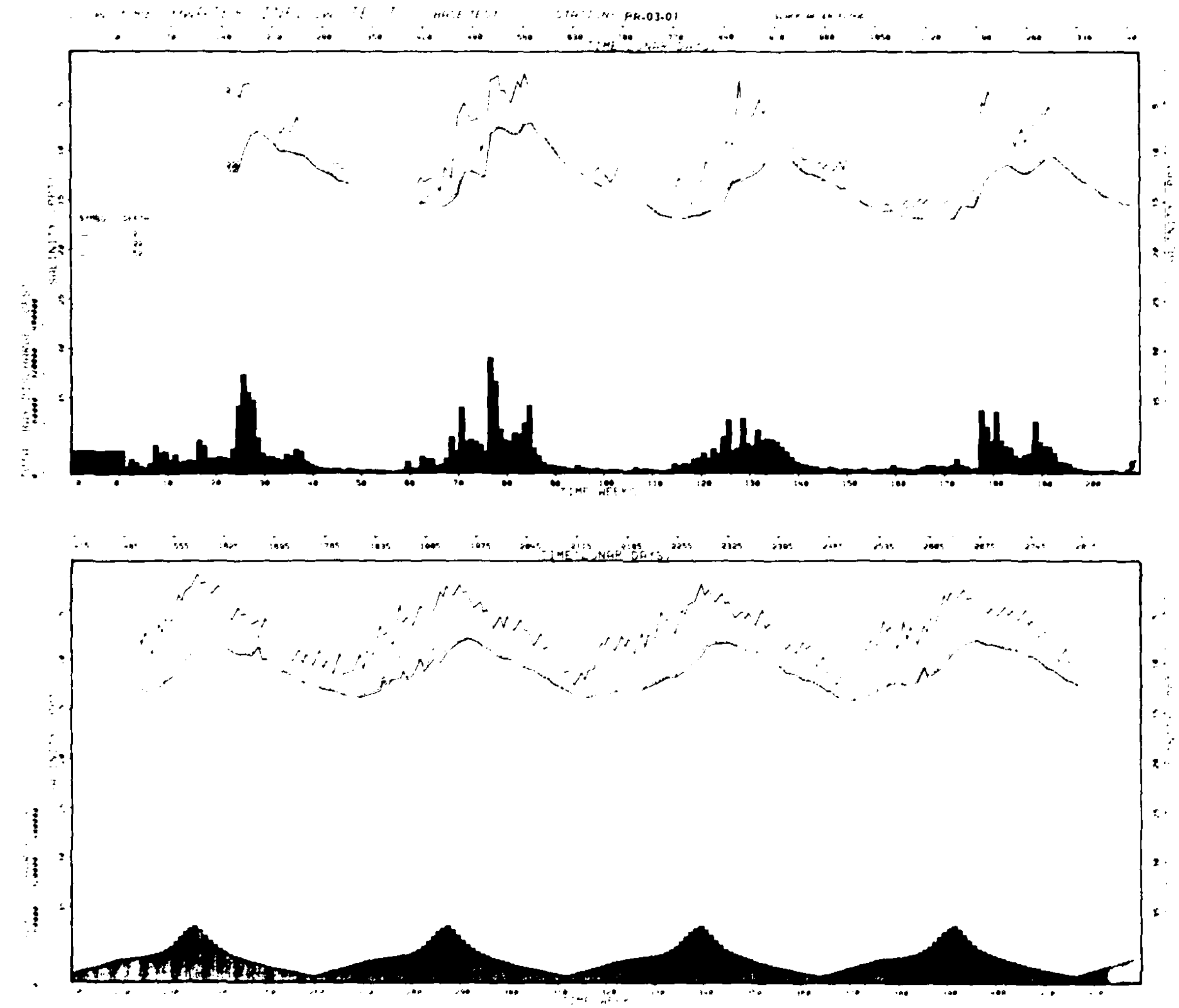


Plate 55. Salinity time-history, Base Test, sta PR-03-01

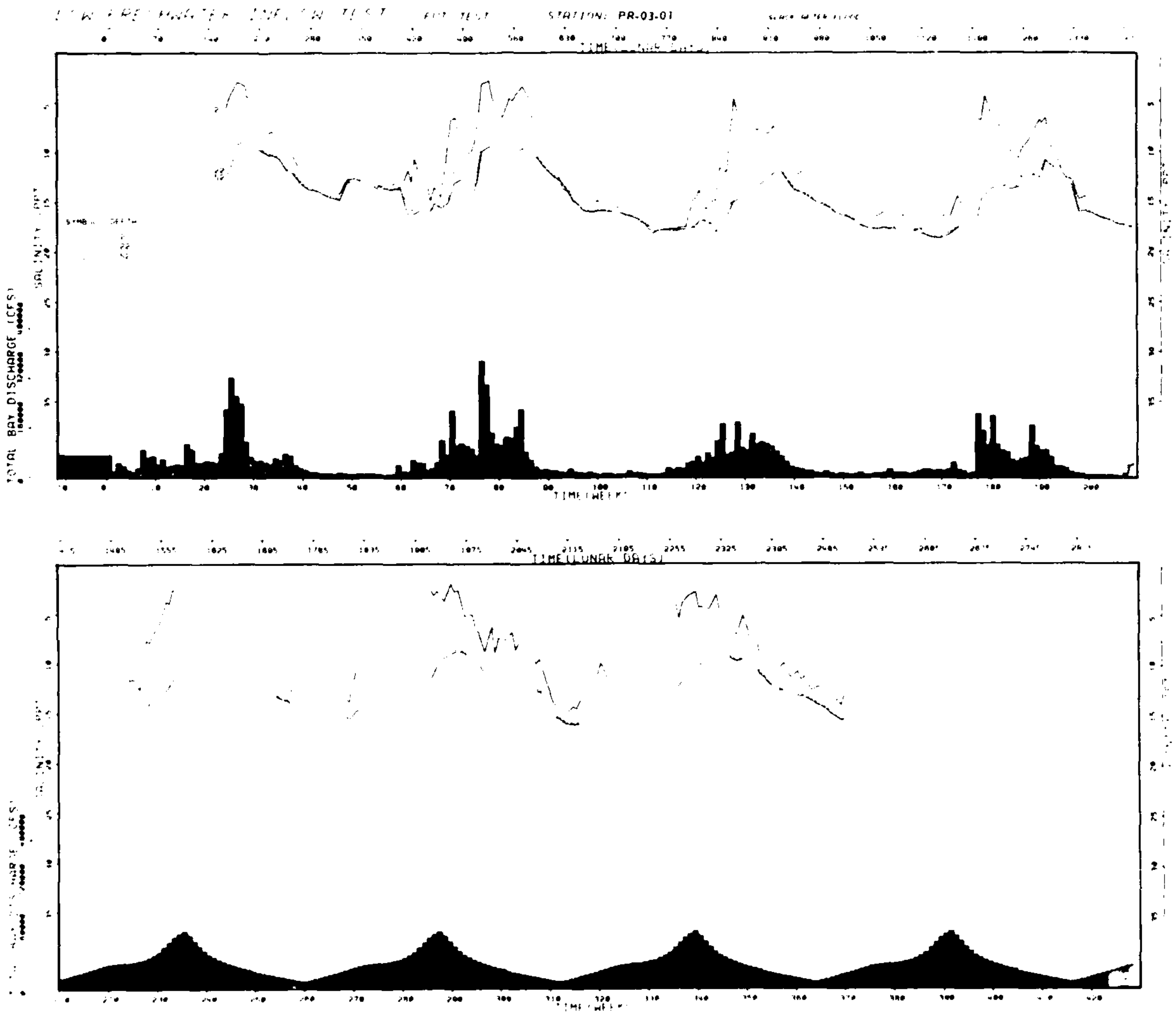


Plate 56. Salinity time—history, Future Test, sta PR-03-01

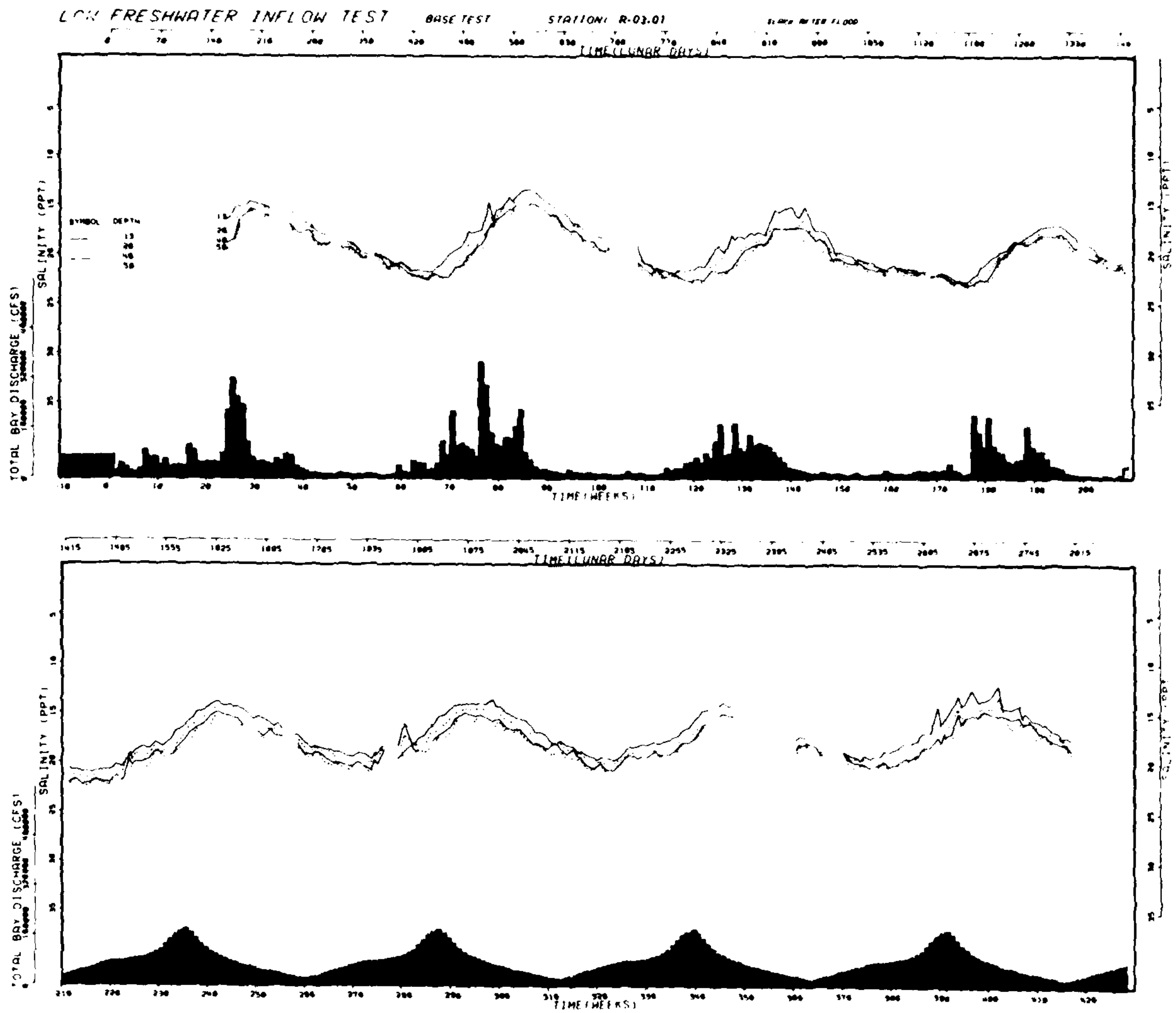


Plate 57. Salinity time-history, Base Test, sta R-03-01

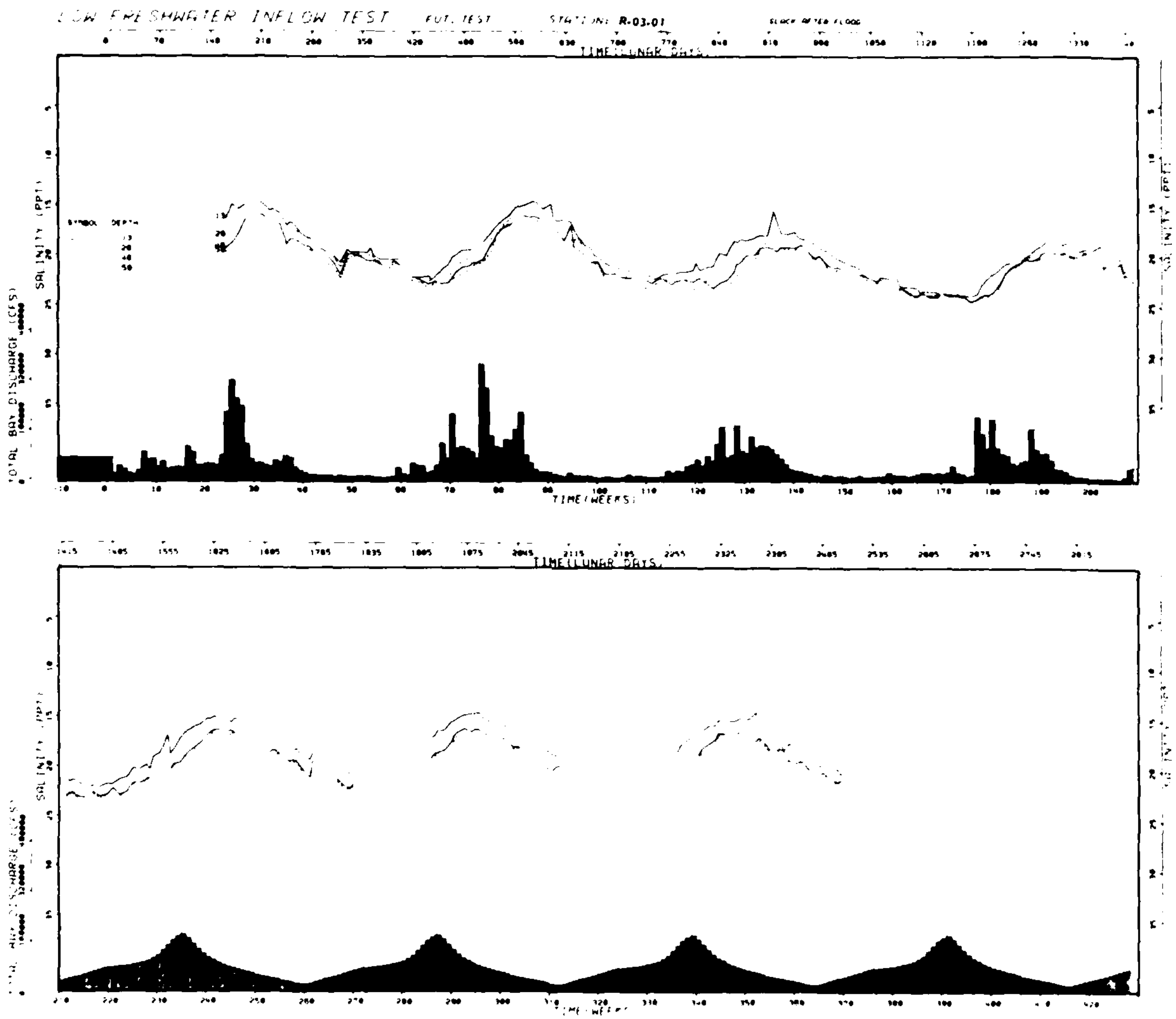


Plate 58. Salinity time-history, Future Test, sta R-03-01

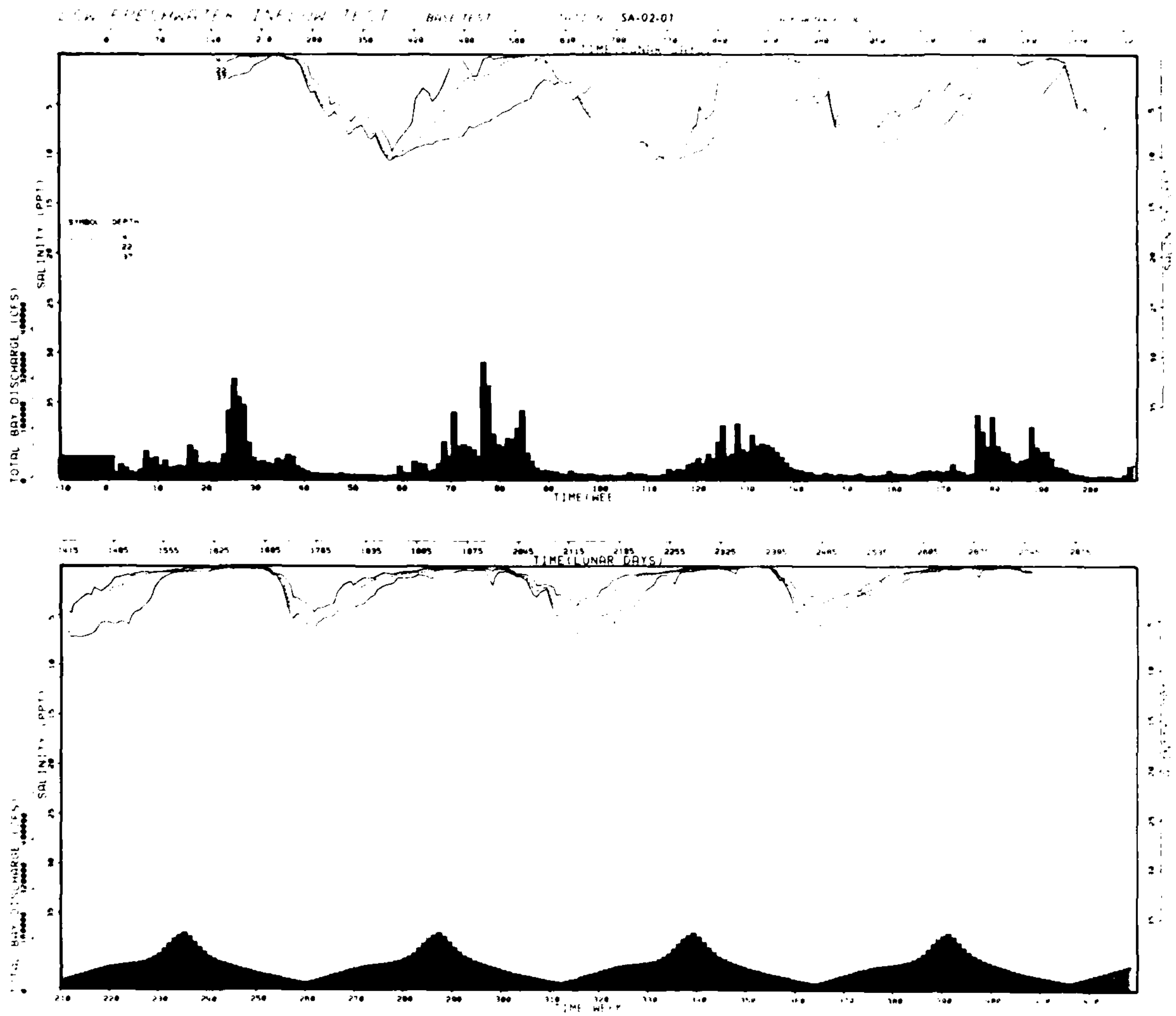


Plate 59. Salinity time-history, Base Test, sta SA-02-01

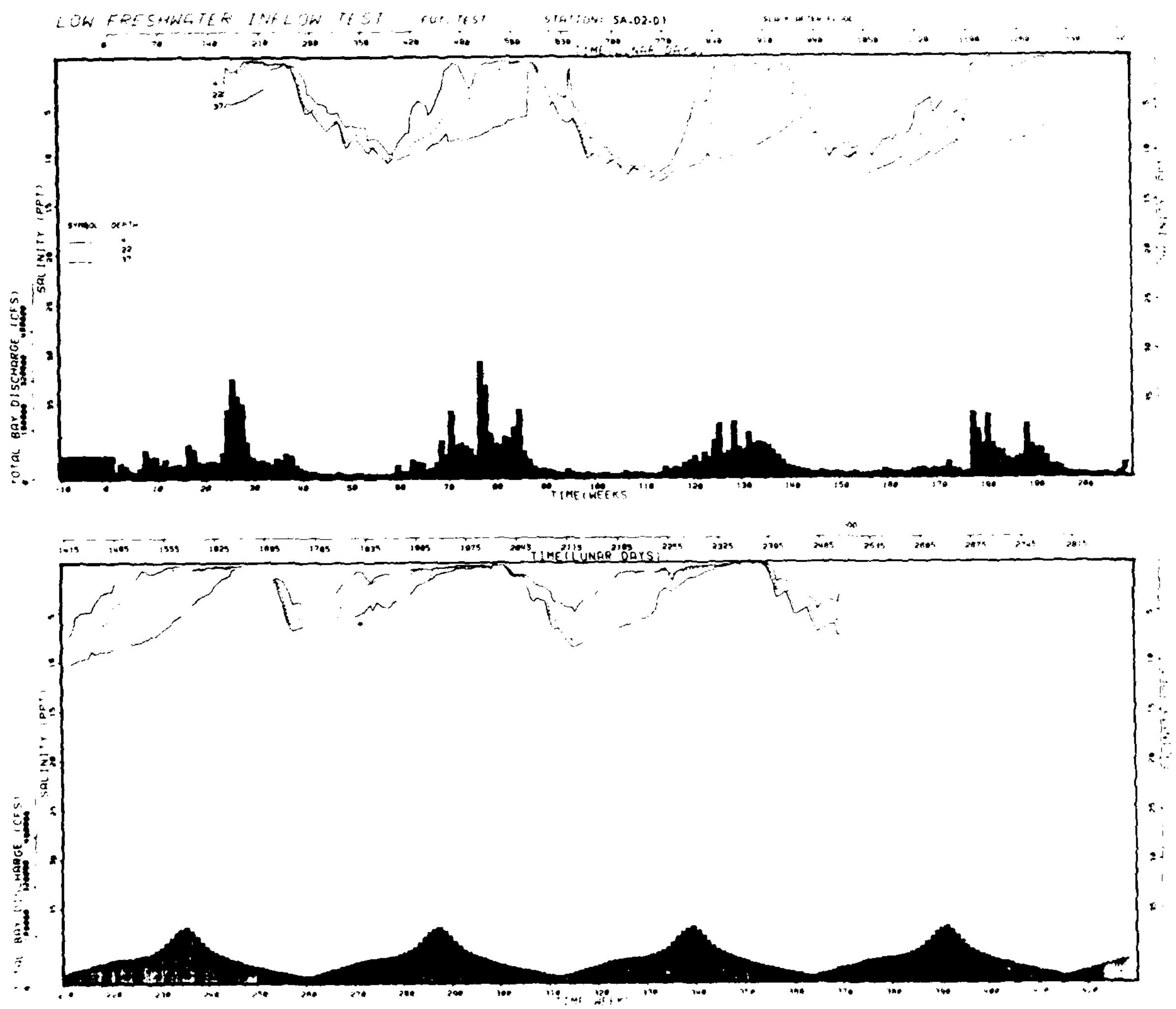


Plate 60. Salinity time-history, Future Test, sta SA-02-01

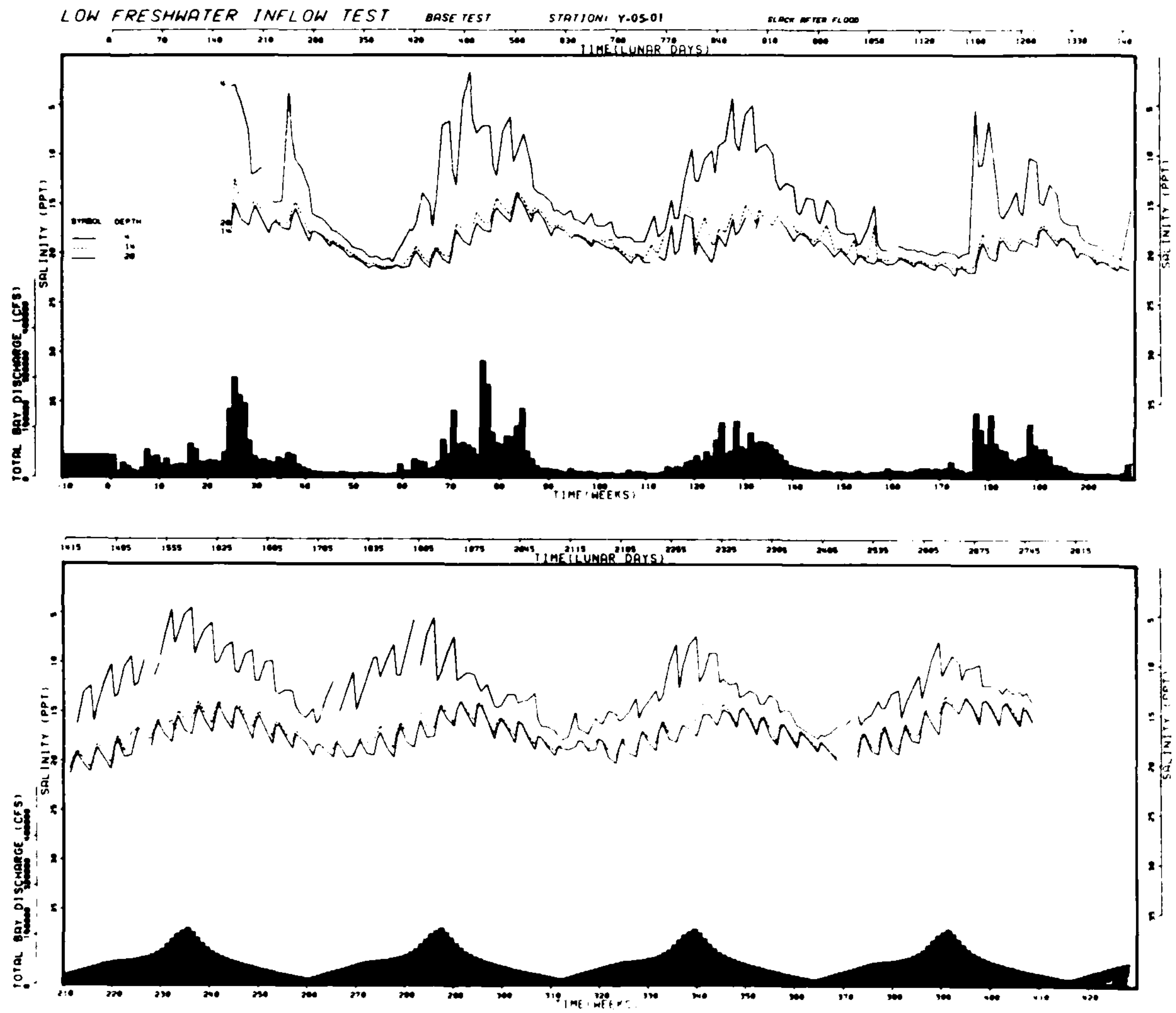


Plate 61. Salinity time-history, Base Test, sta Y-05-01

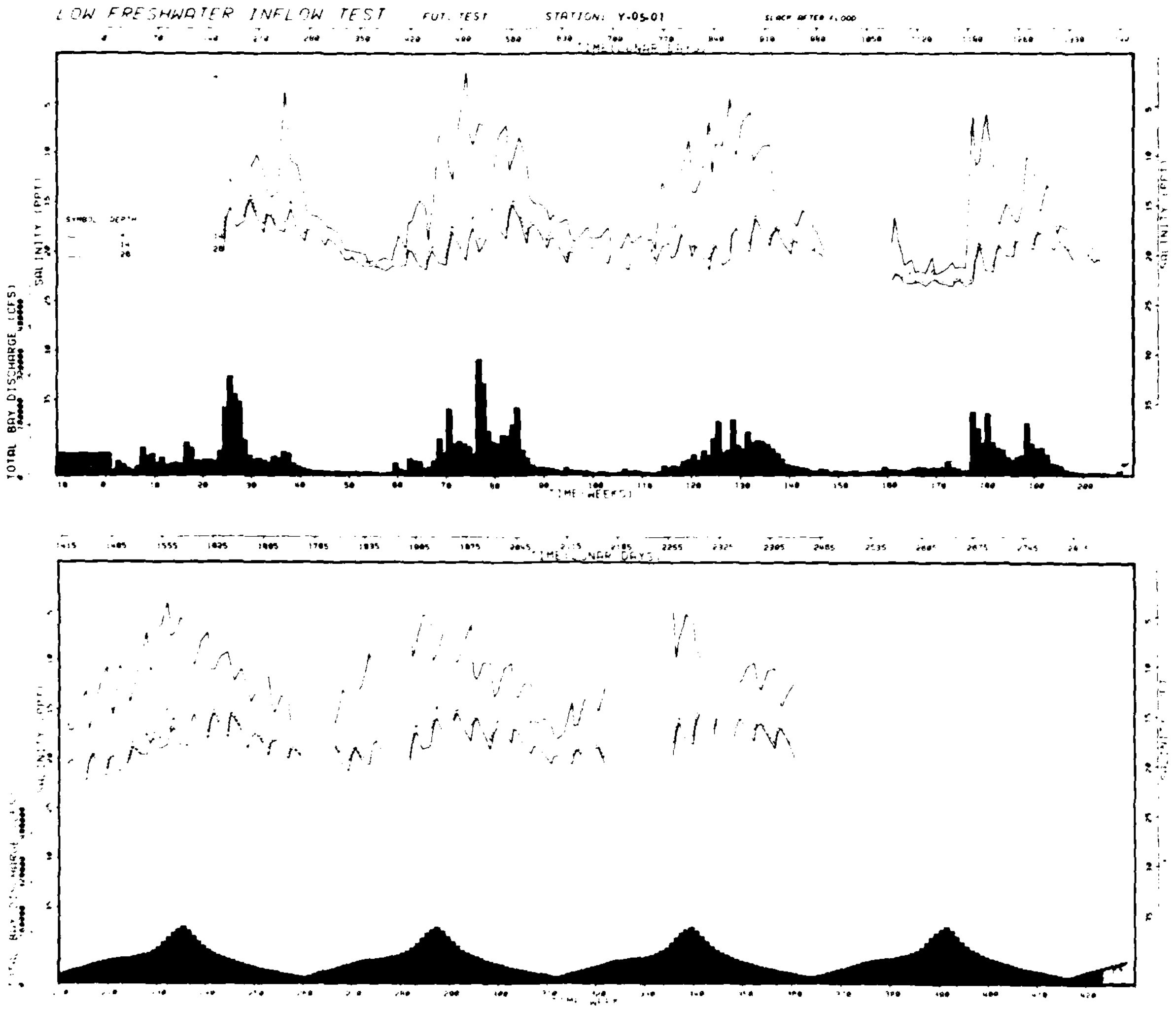


Plate 62. Salinity time-history, Future Test, sta Y-05-01

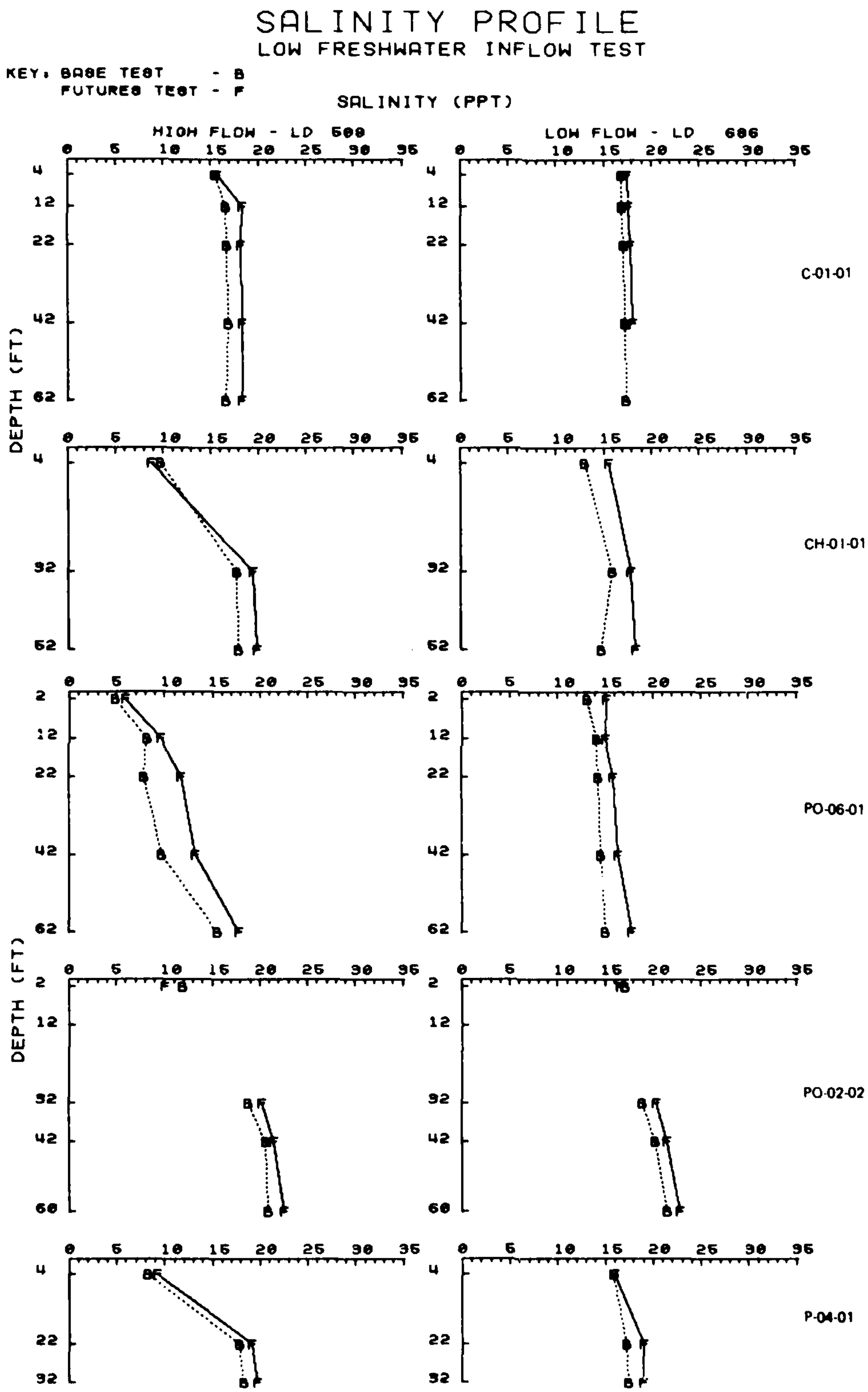


Plate 63. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 509 and 686

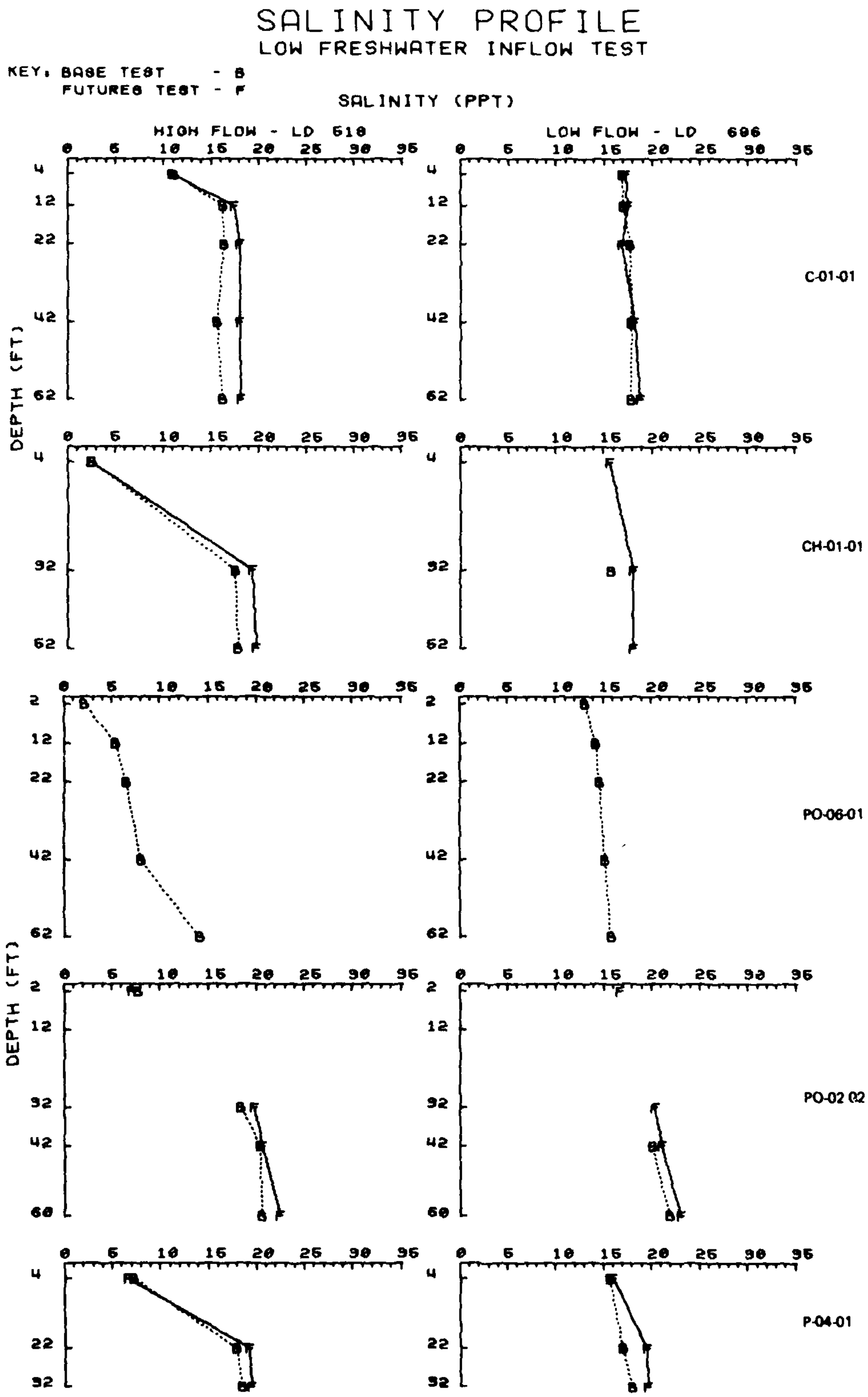


Plate 64. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 518 and 696

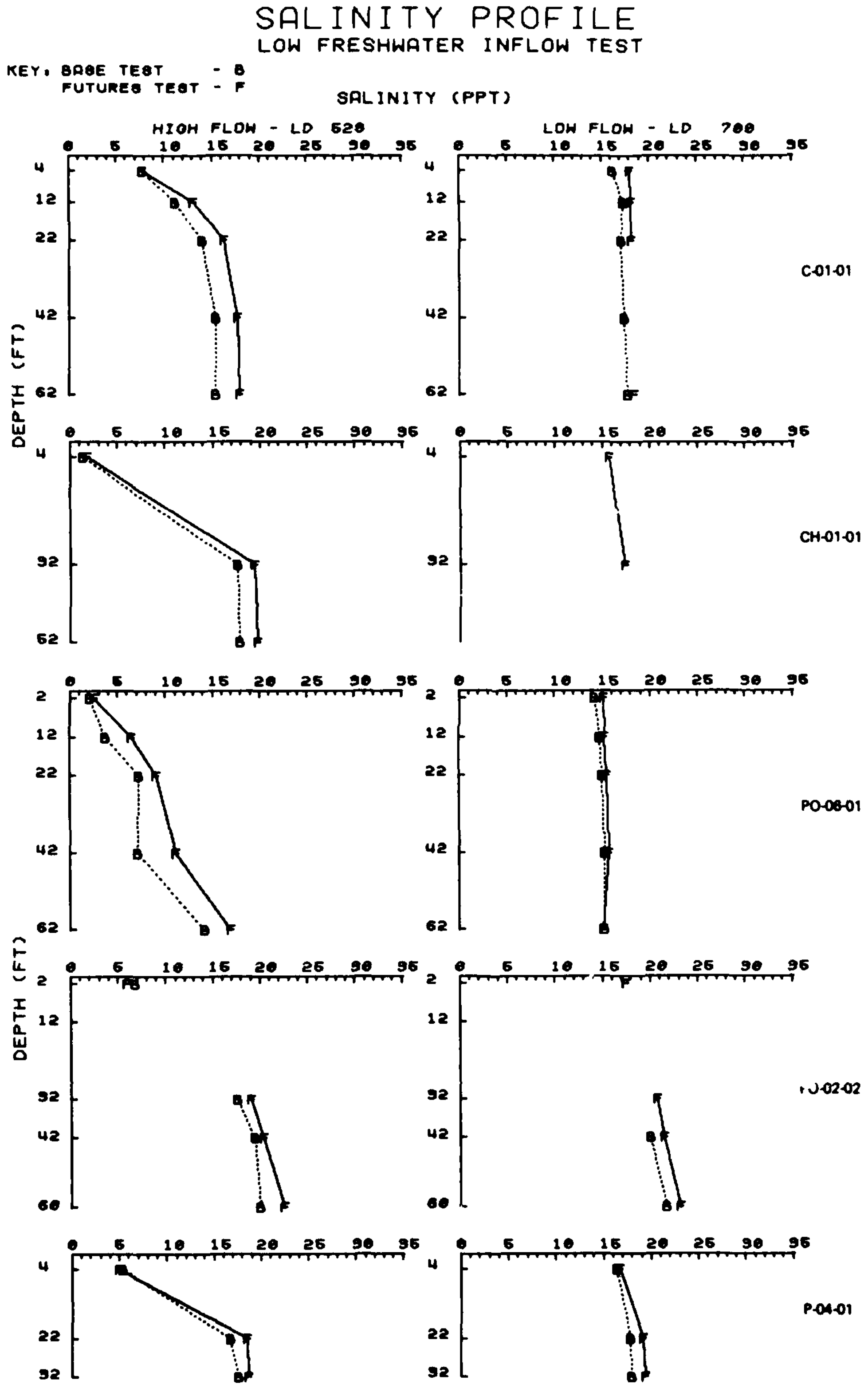


Plate 65. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 528 and 700

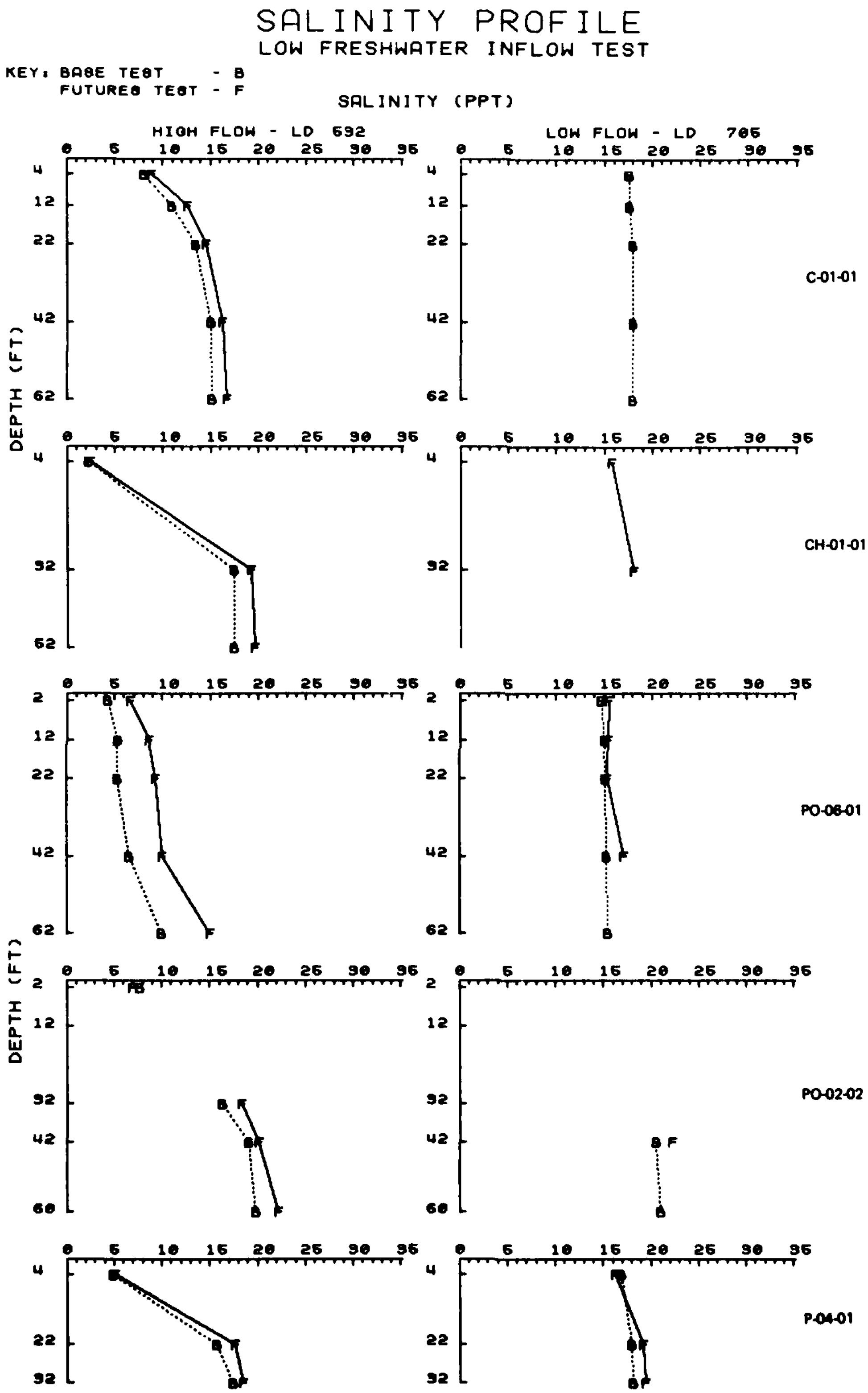


Plate 66. Salinity profiles,sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 592 and 705

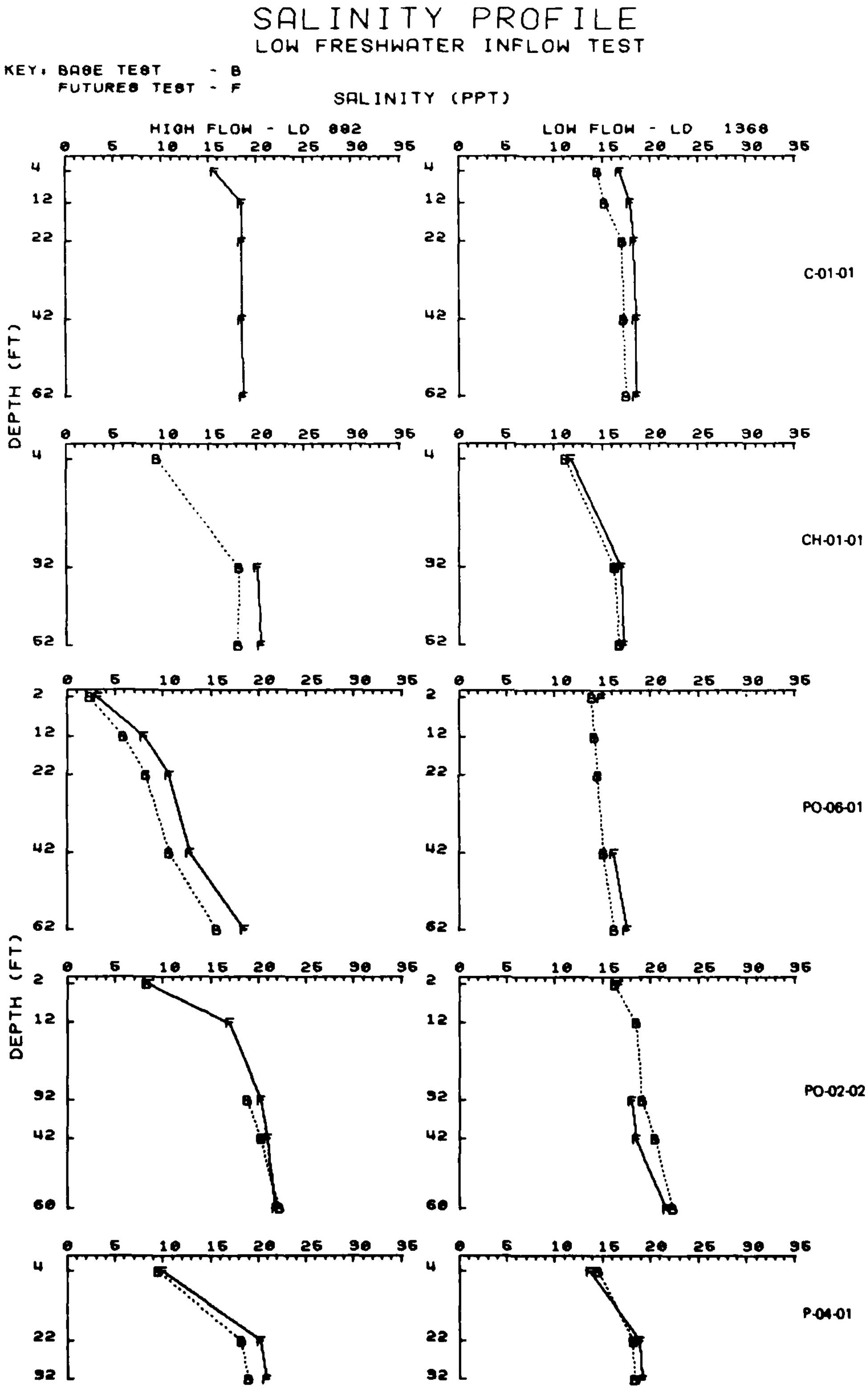


Plate 67. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 892 and 1368

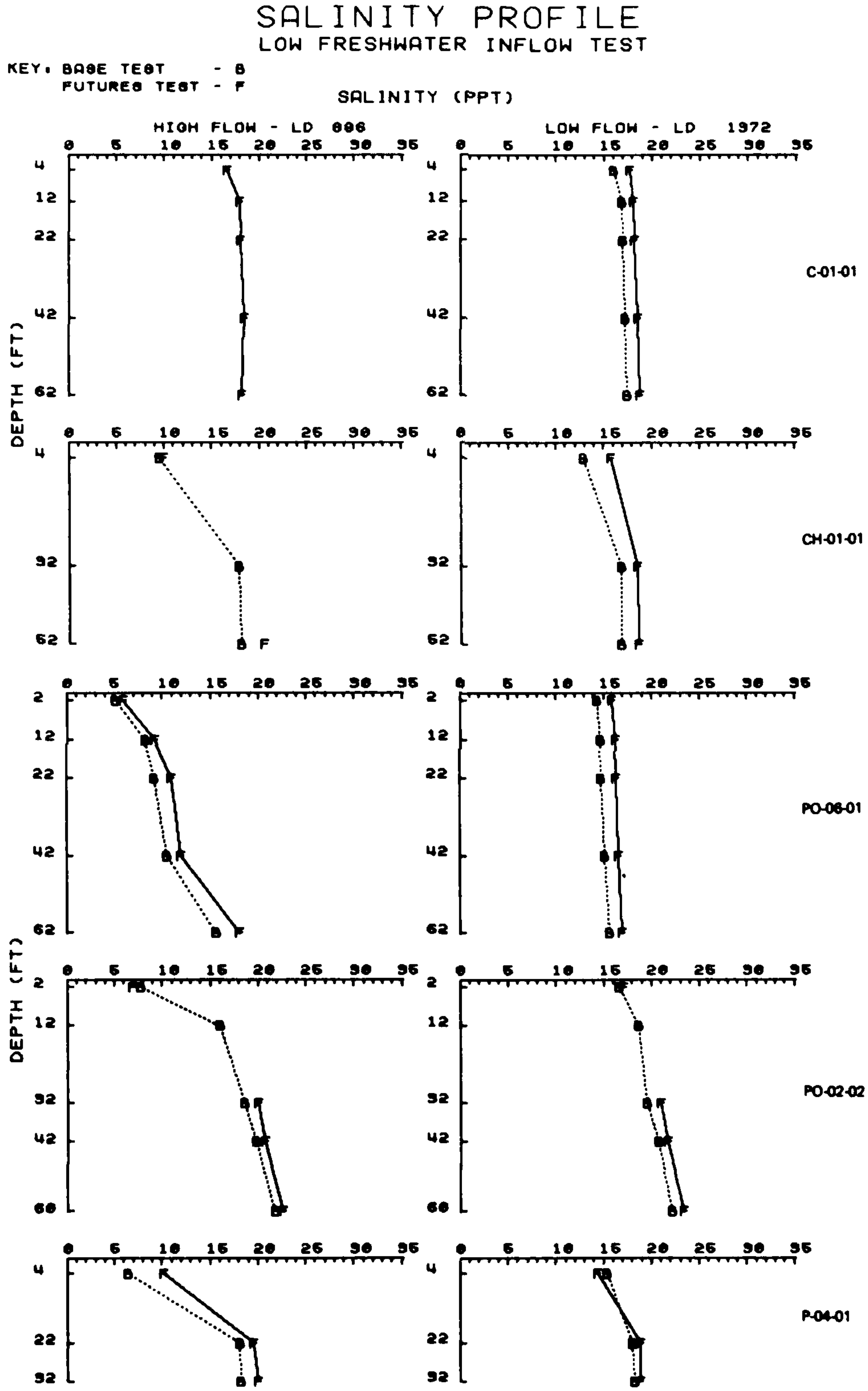


Plate 68. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 896 and 1372

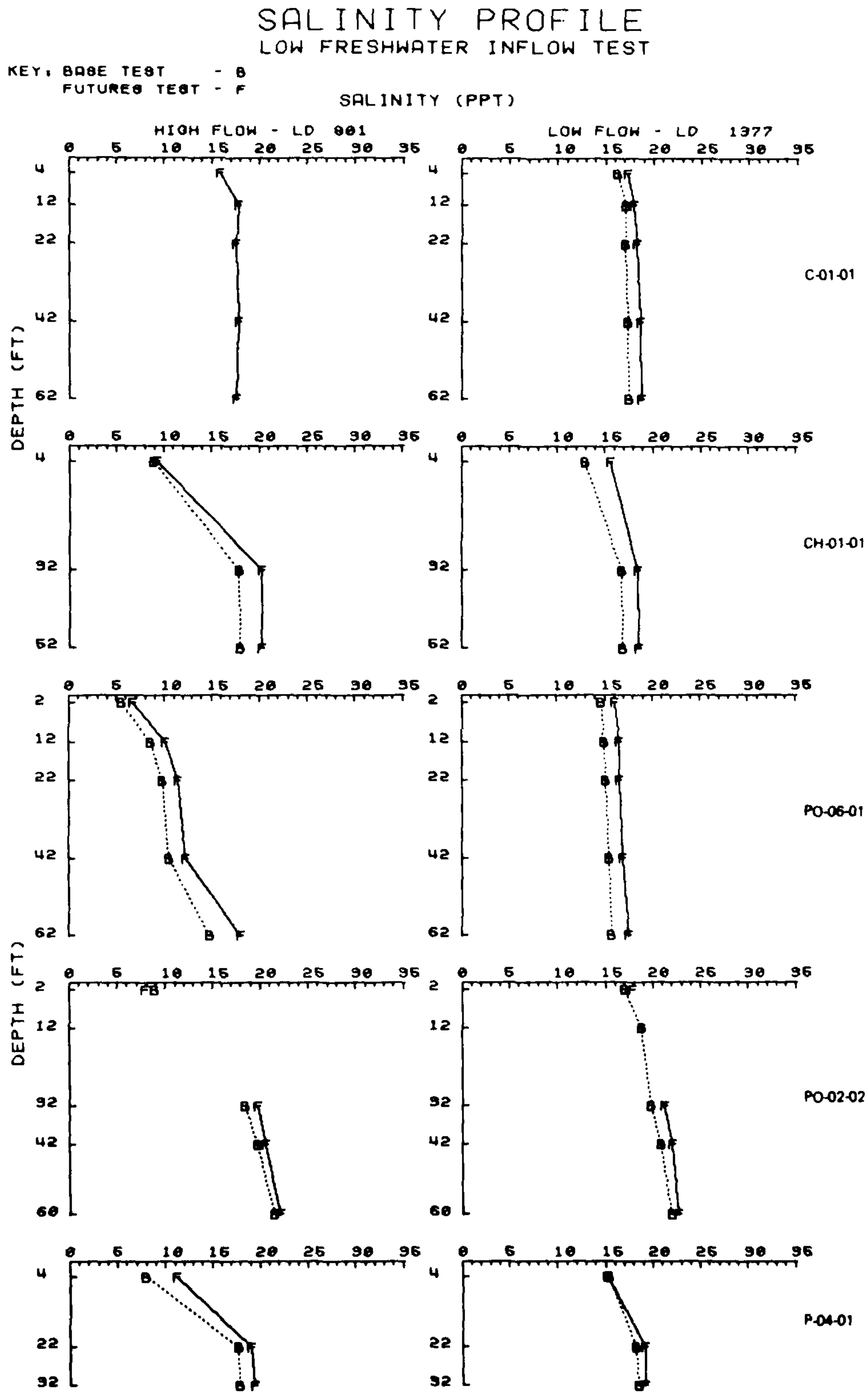


Plate 69. Salinity profiles, sta C-01-01, SH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 901 and 1377

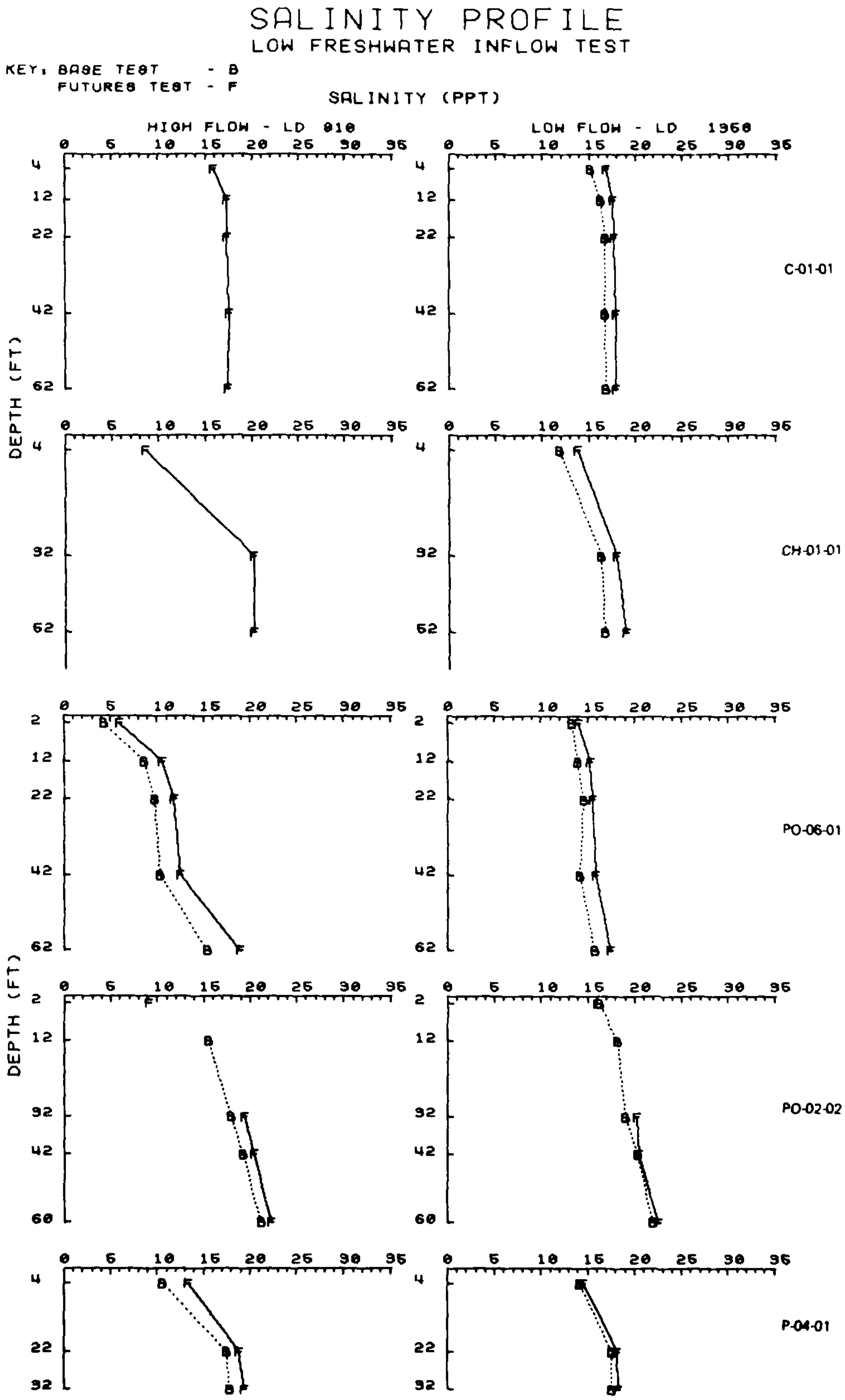


Plate 70. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 910 and 1358

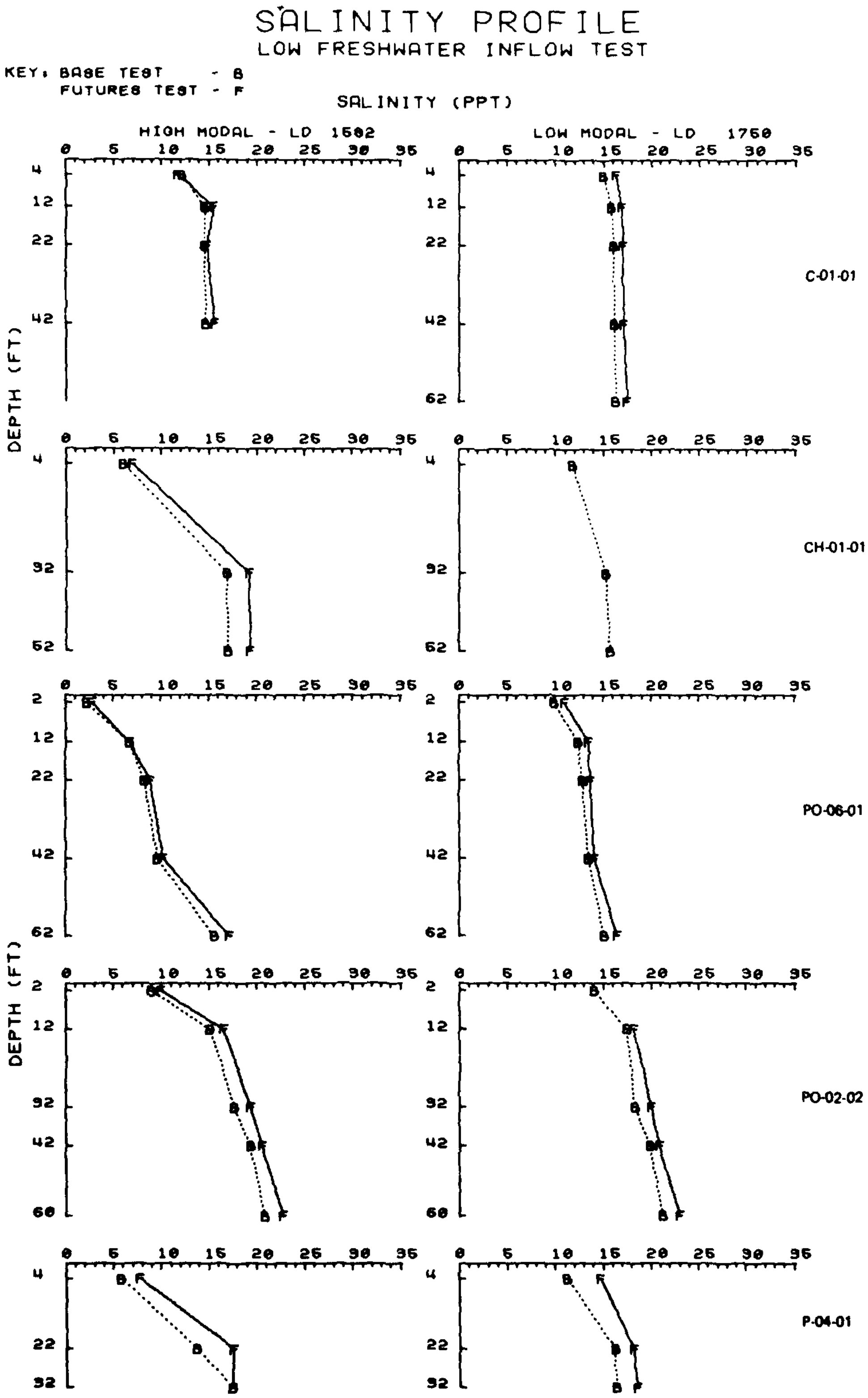


Plate 71. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 1582 and 1750

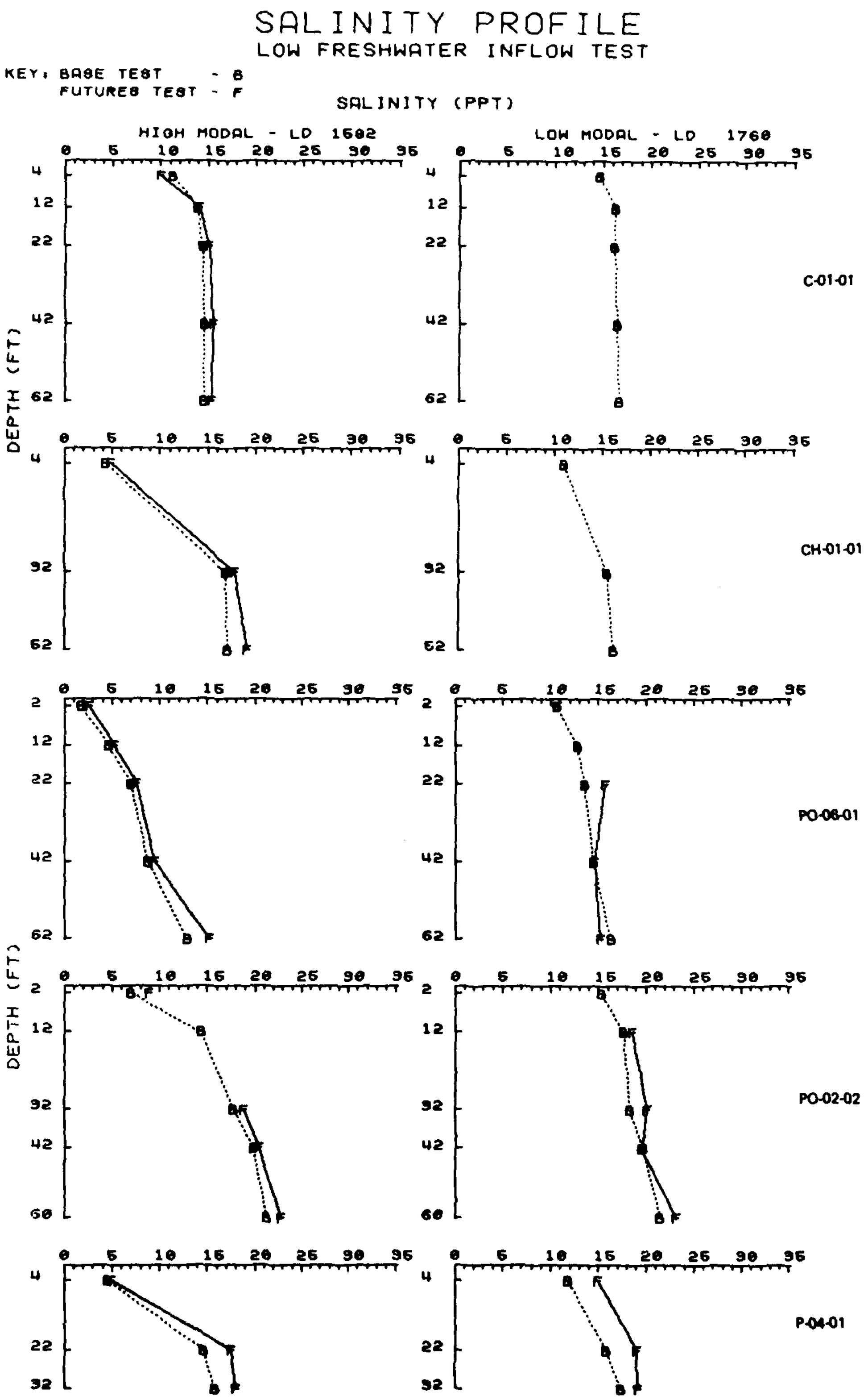


Plate 72. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 1592 and 1760

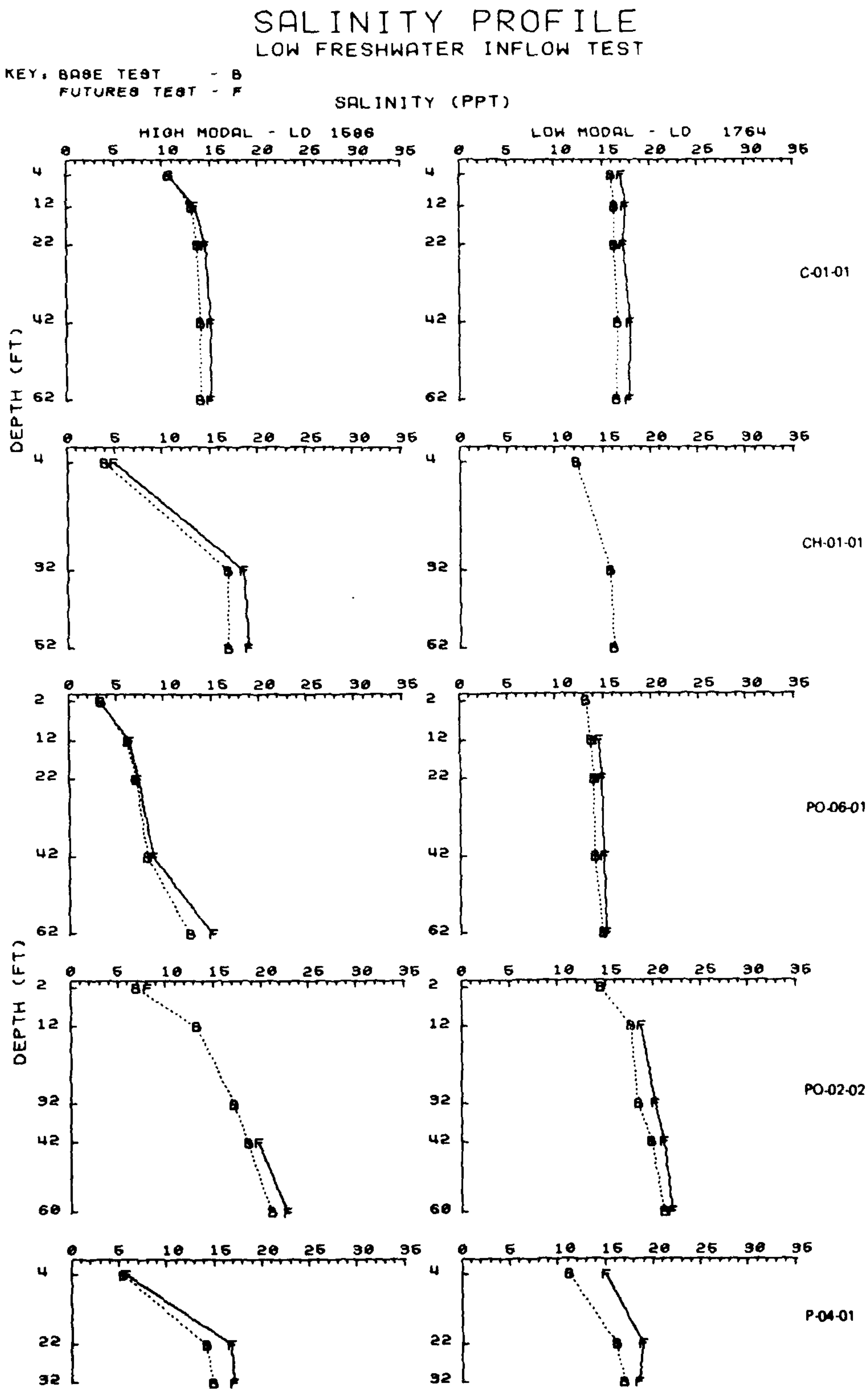


Plate 73. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 1596 and 1764

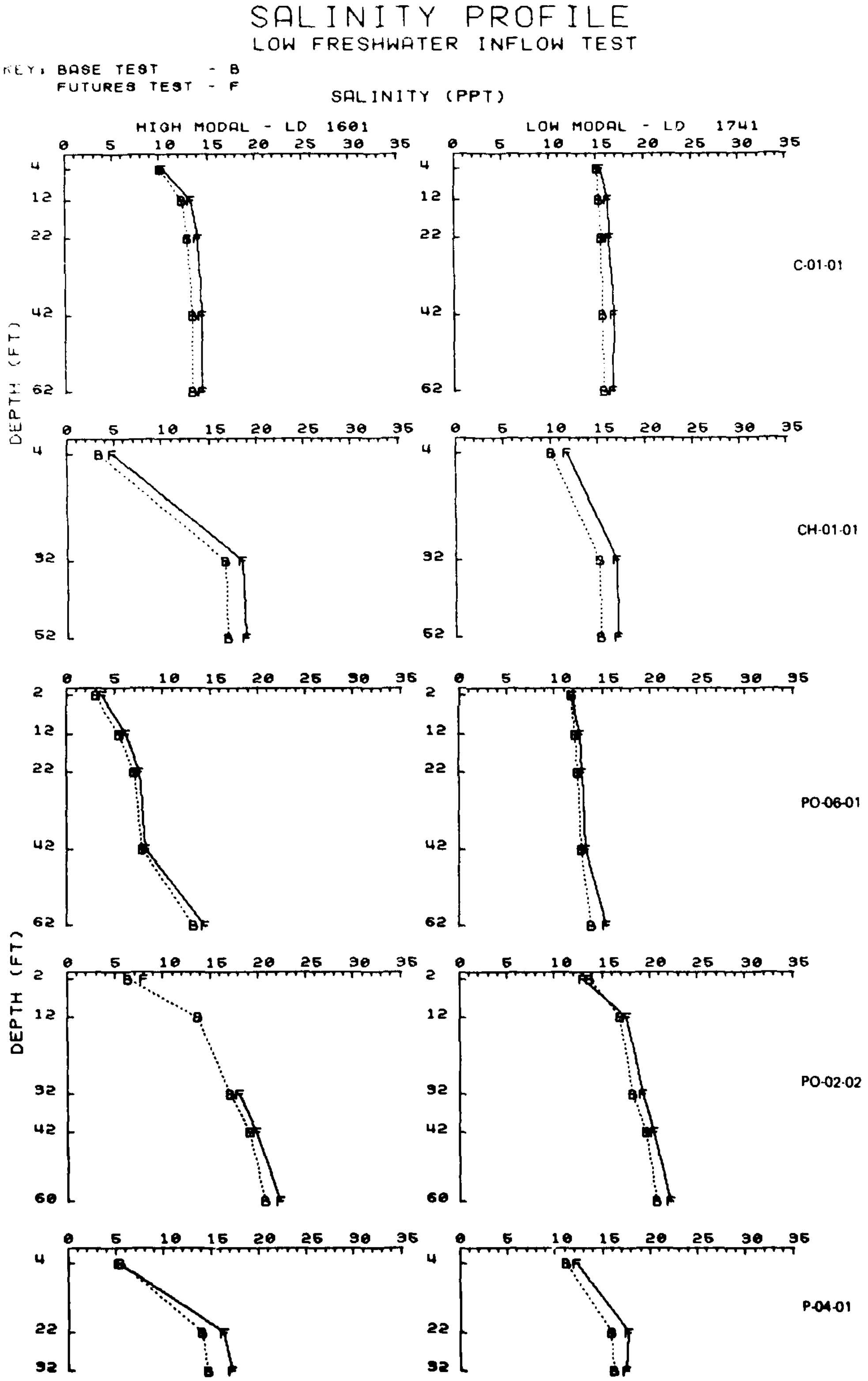


Plate 74. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 1601 and 1741

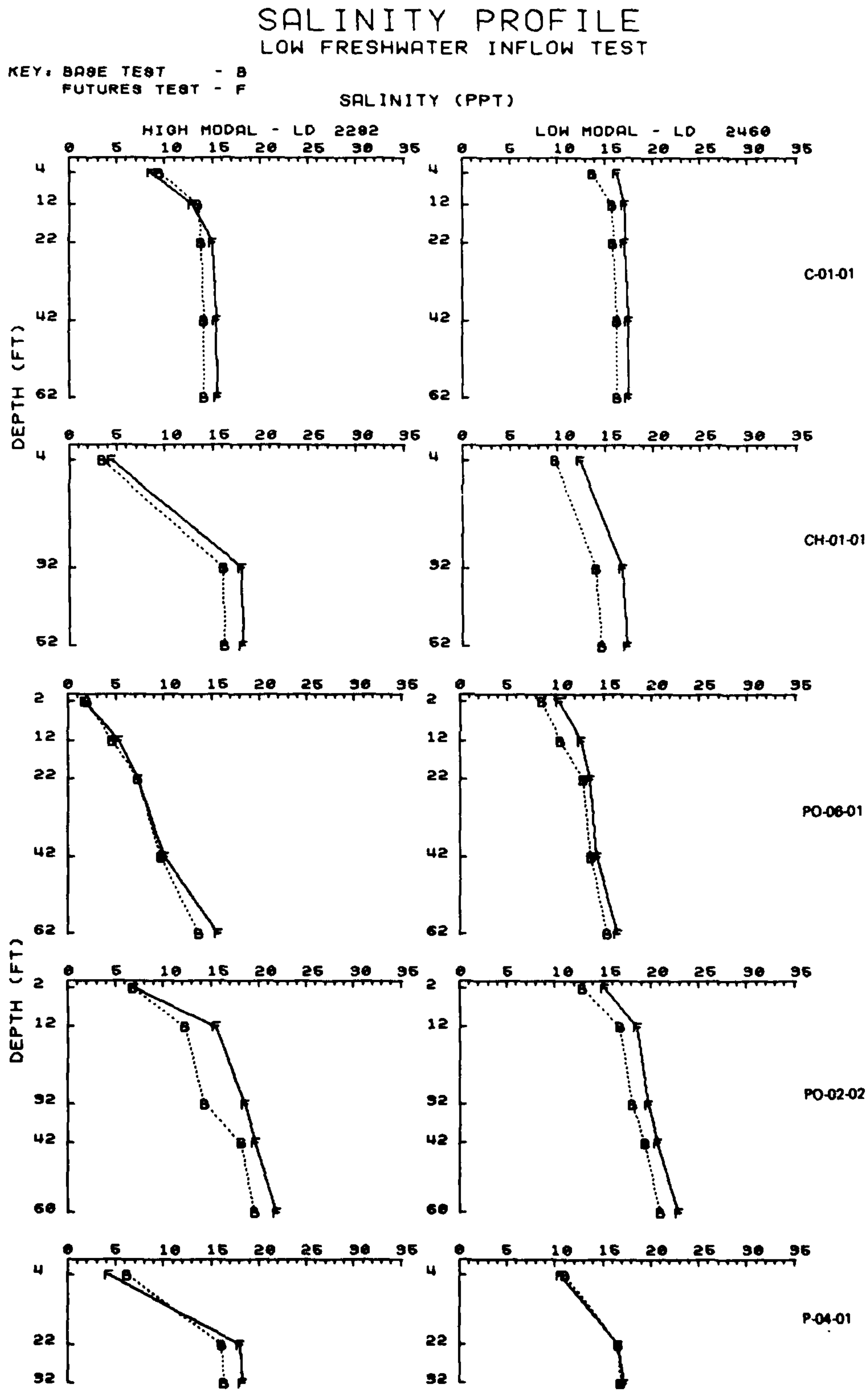


Plate 75. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 2292 and 2460

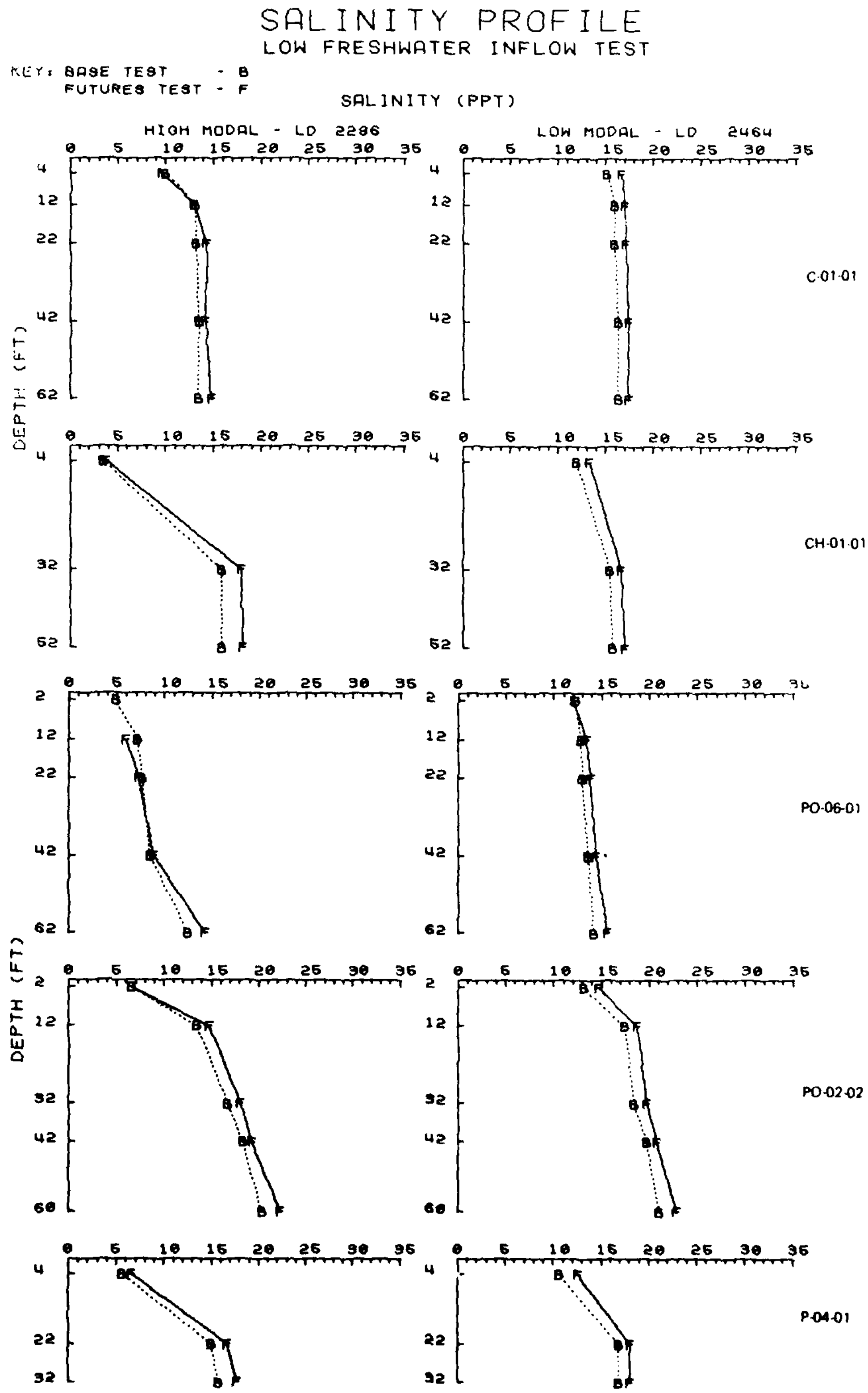


Plate 76. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 2296 and 2464

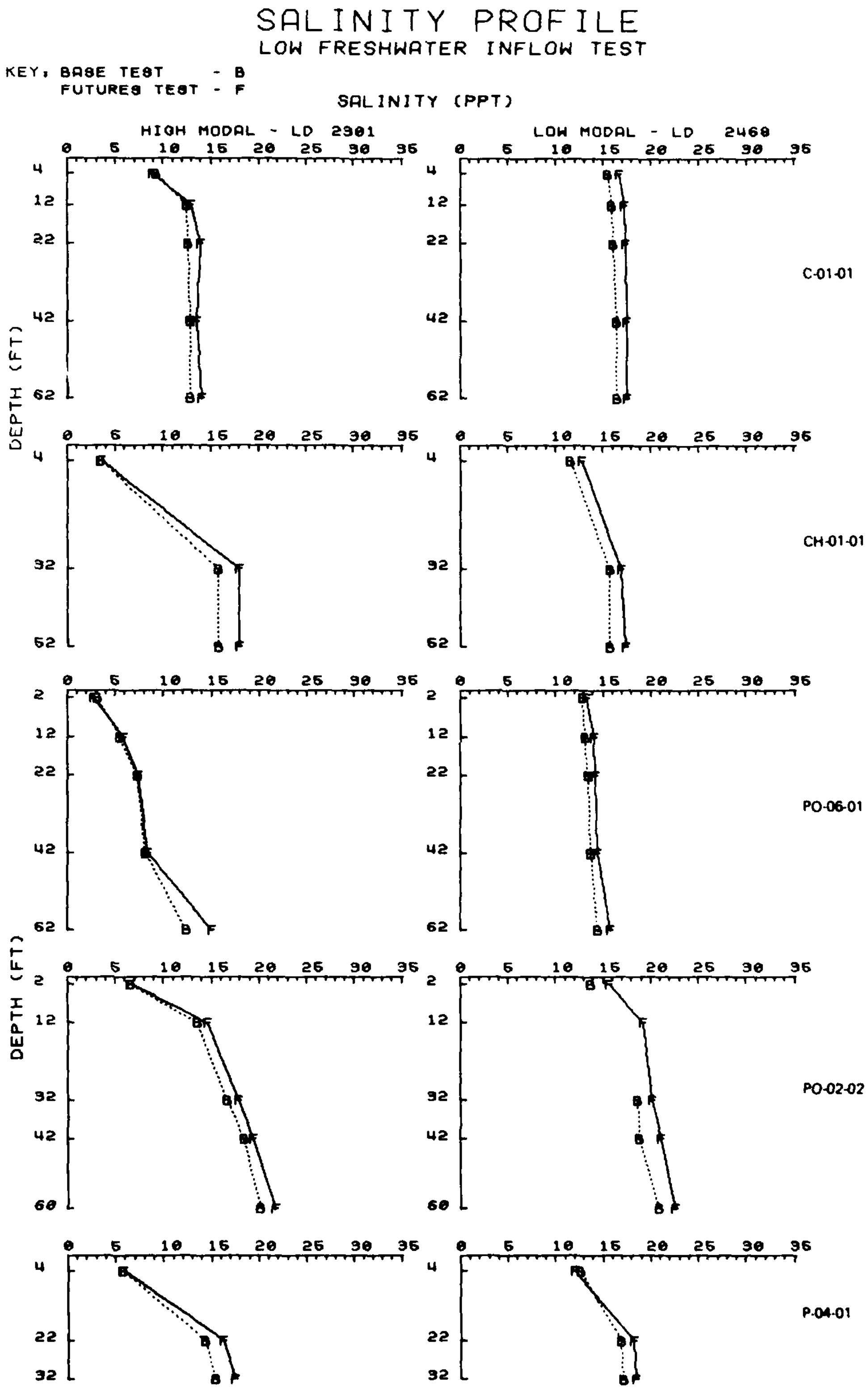


Plate 77. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 2301 and 2469

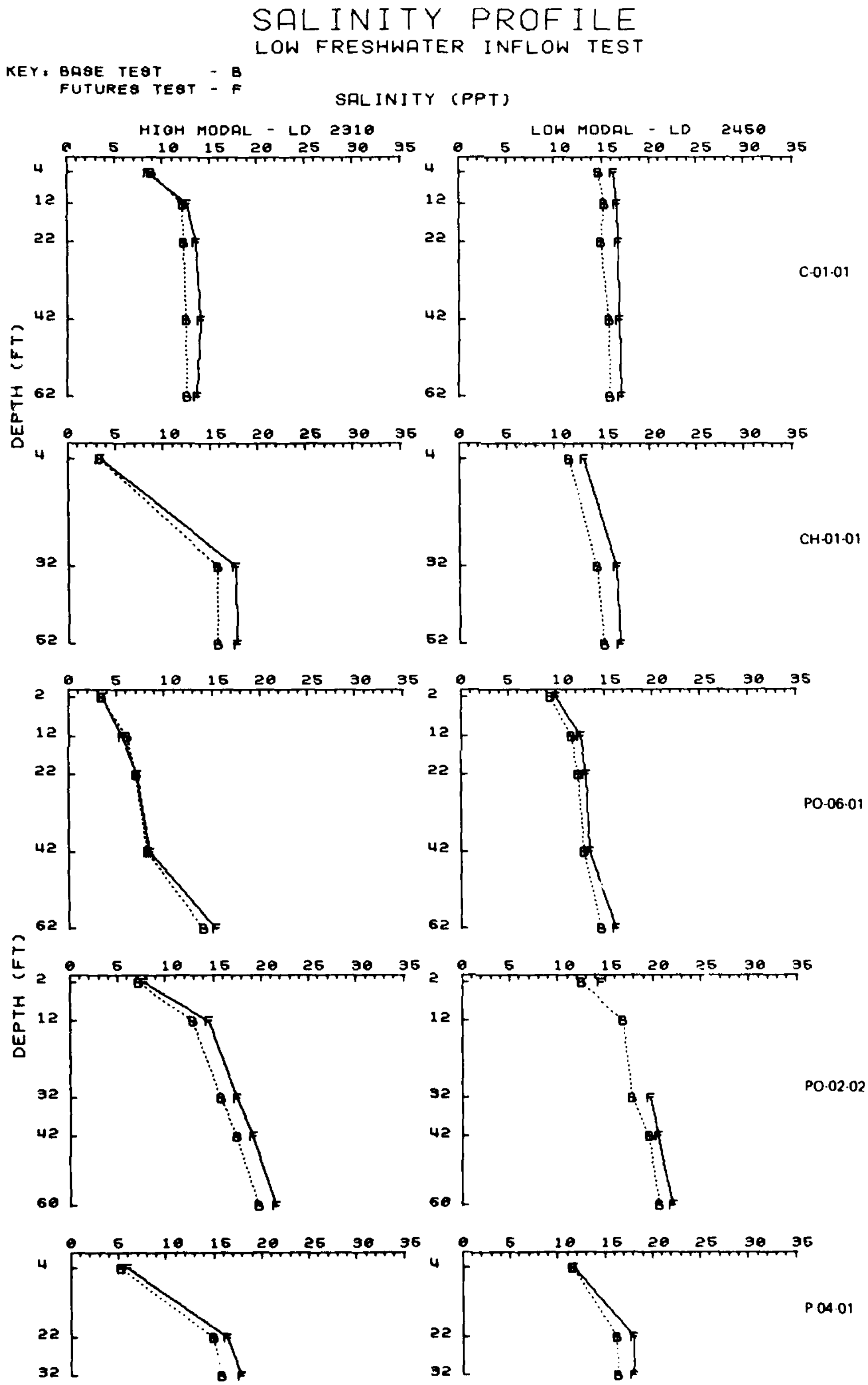


Plate 78. Salinity profiles, sta C-01-01, CH-01-01, PO-06-01, PO-02-02, and P-04-01, lunar days 2310 and 2450

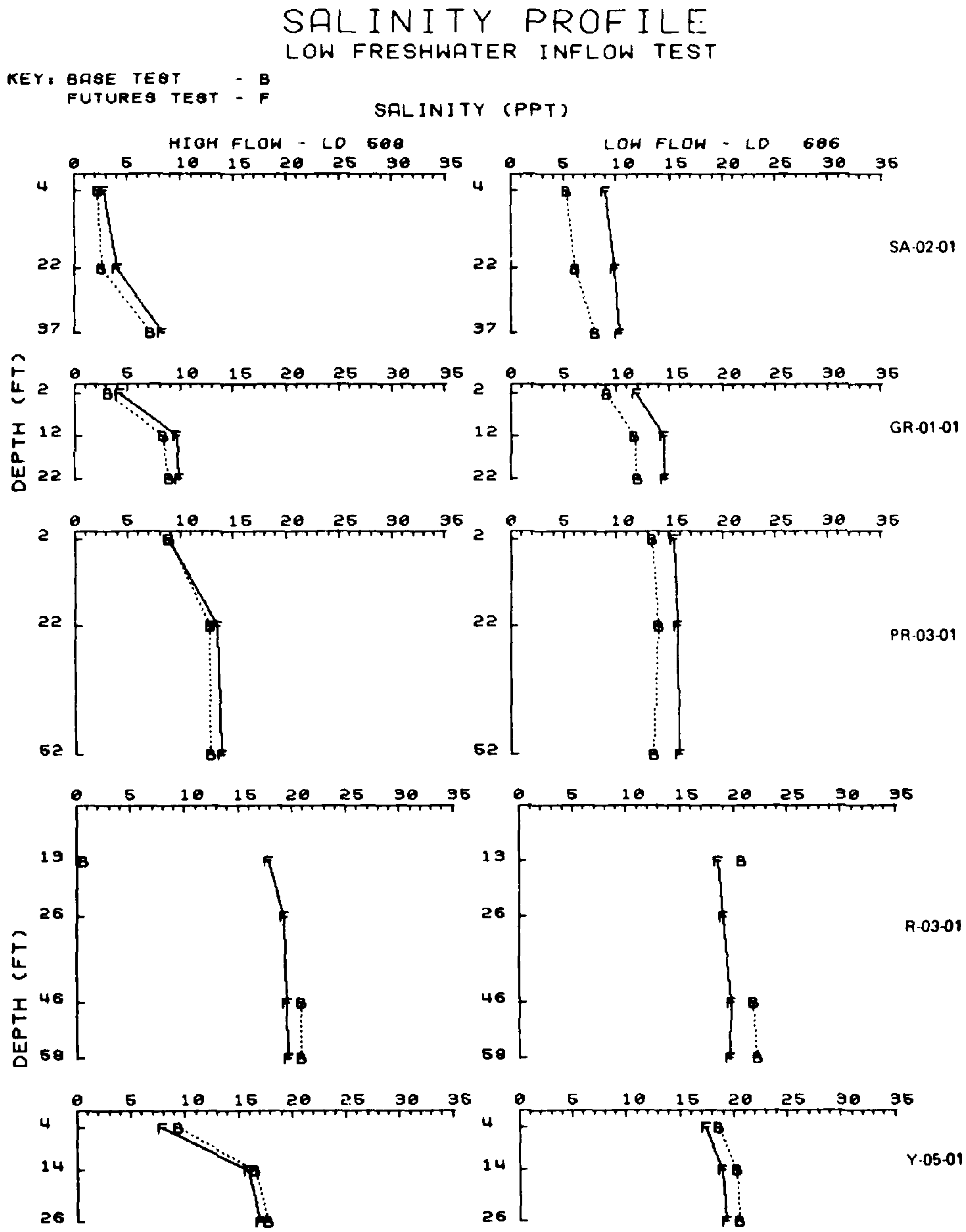


Plate 79. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 509 and 686

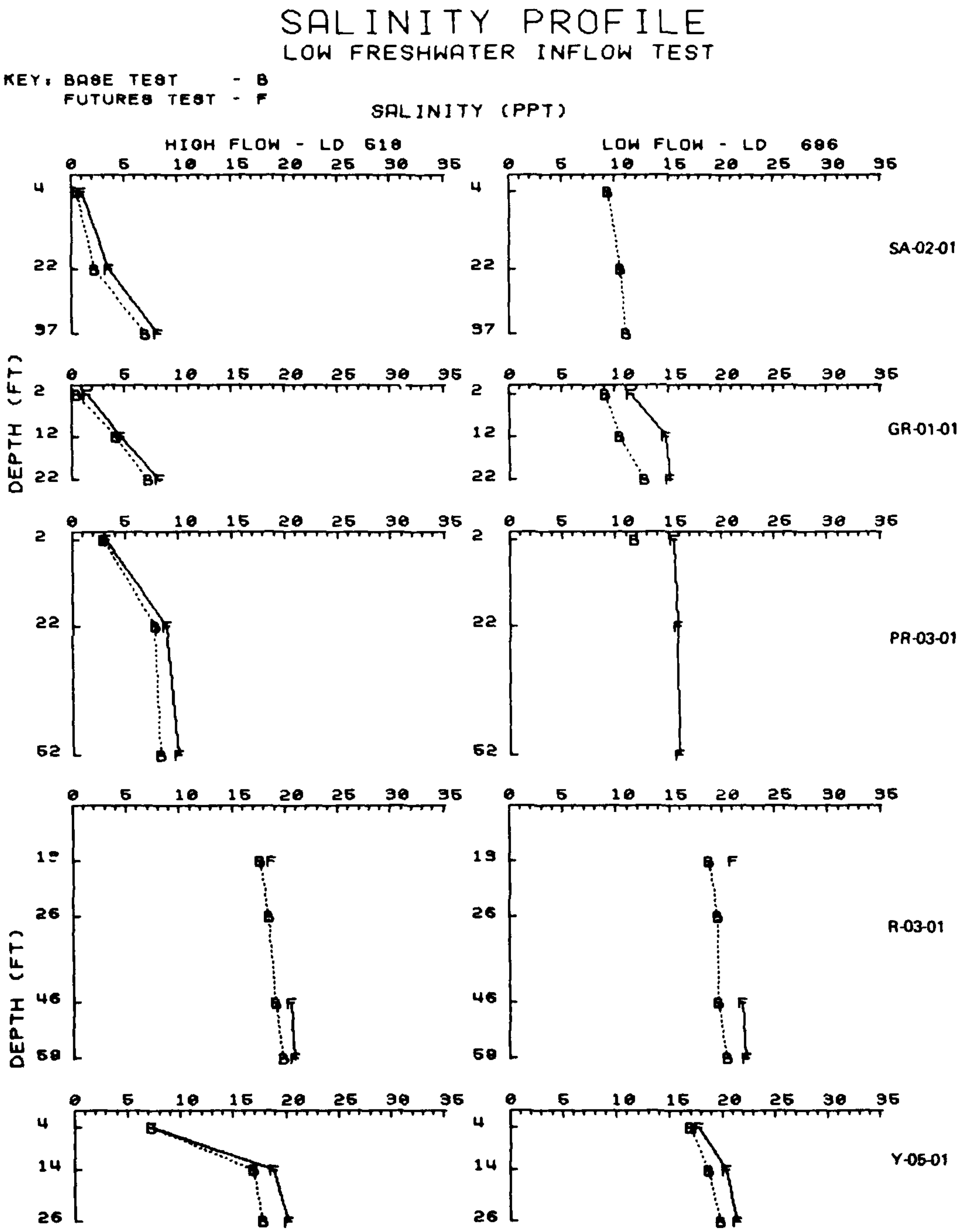


Plate 80. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 510 and 696

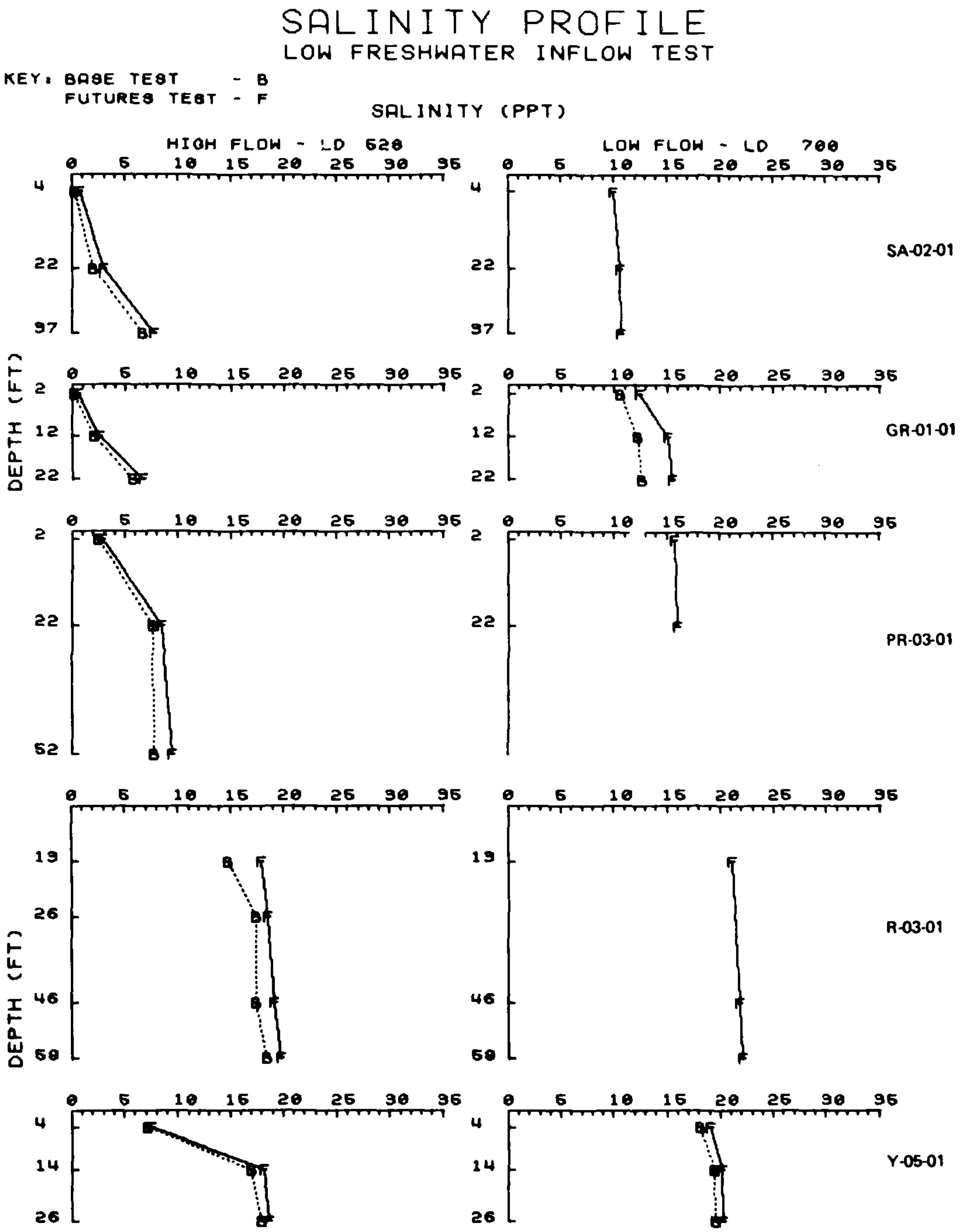


Plate 81. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 528 and 700

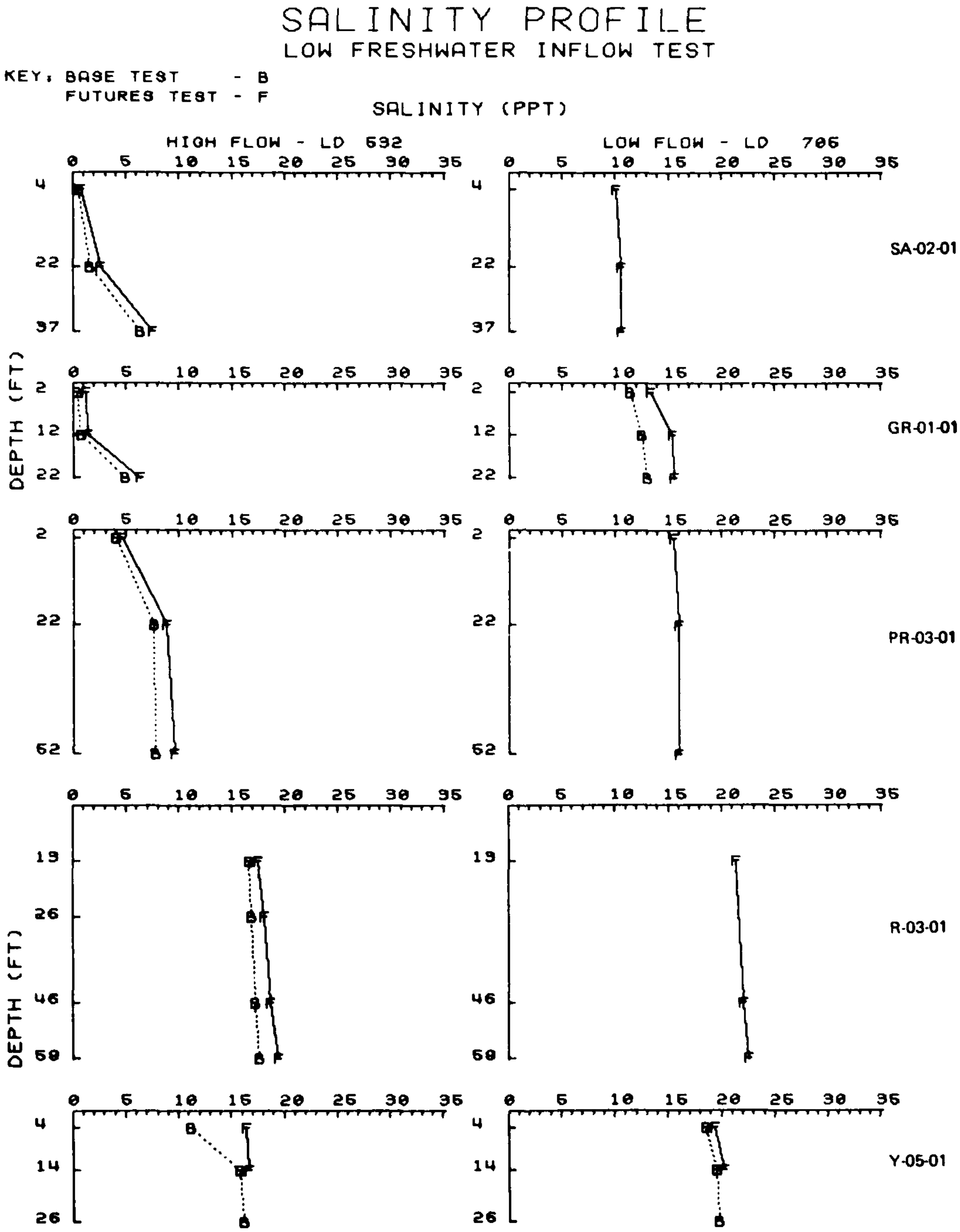


Plate 82. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 532 and 705

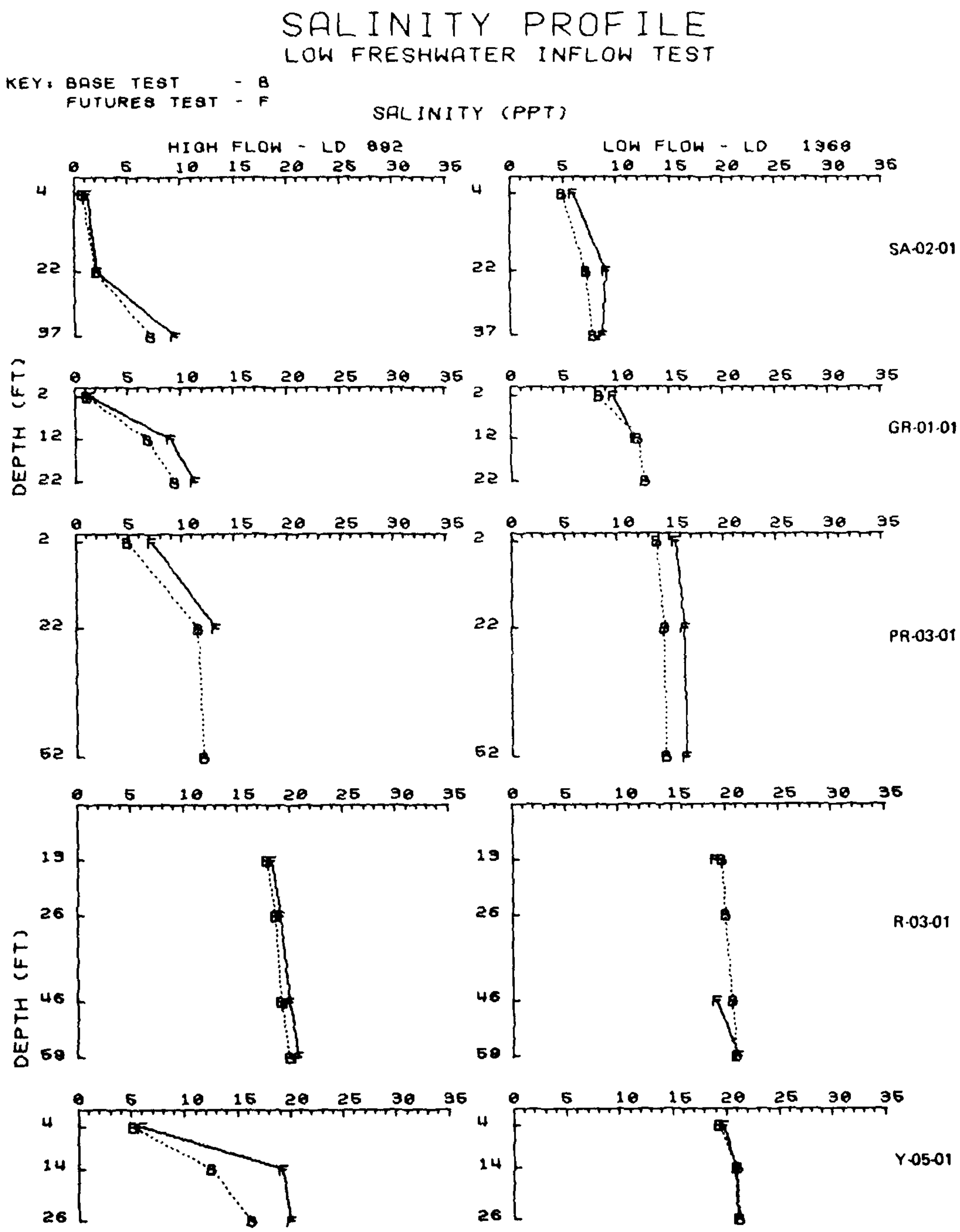


Plate 83. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 892 and 1368

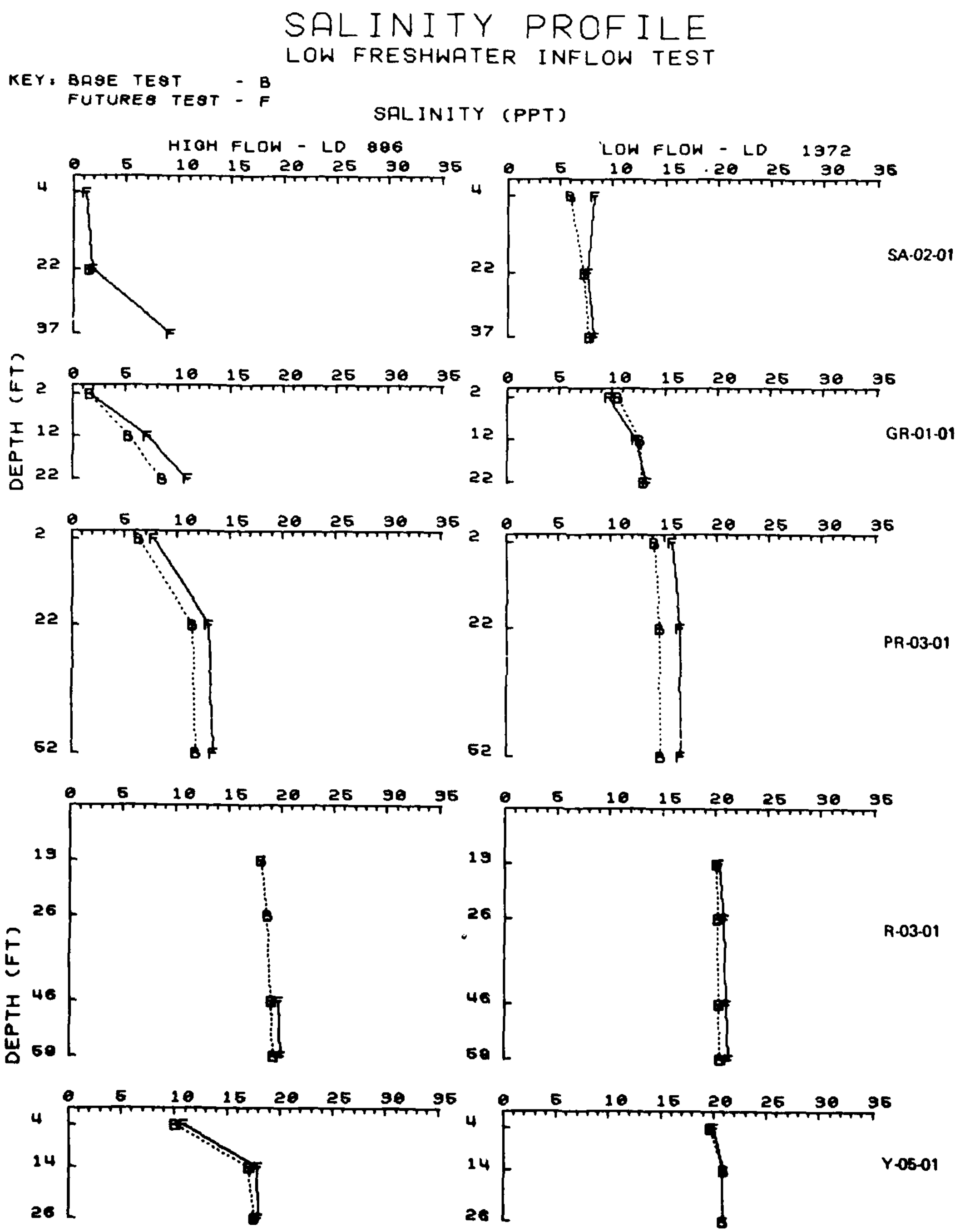


Plate 84. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 896 and 1372

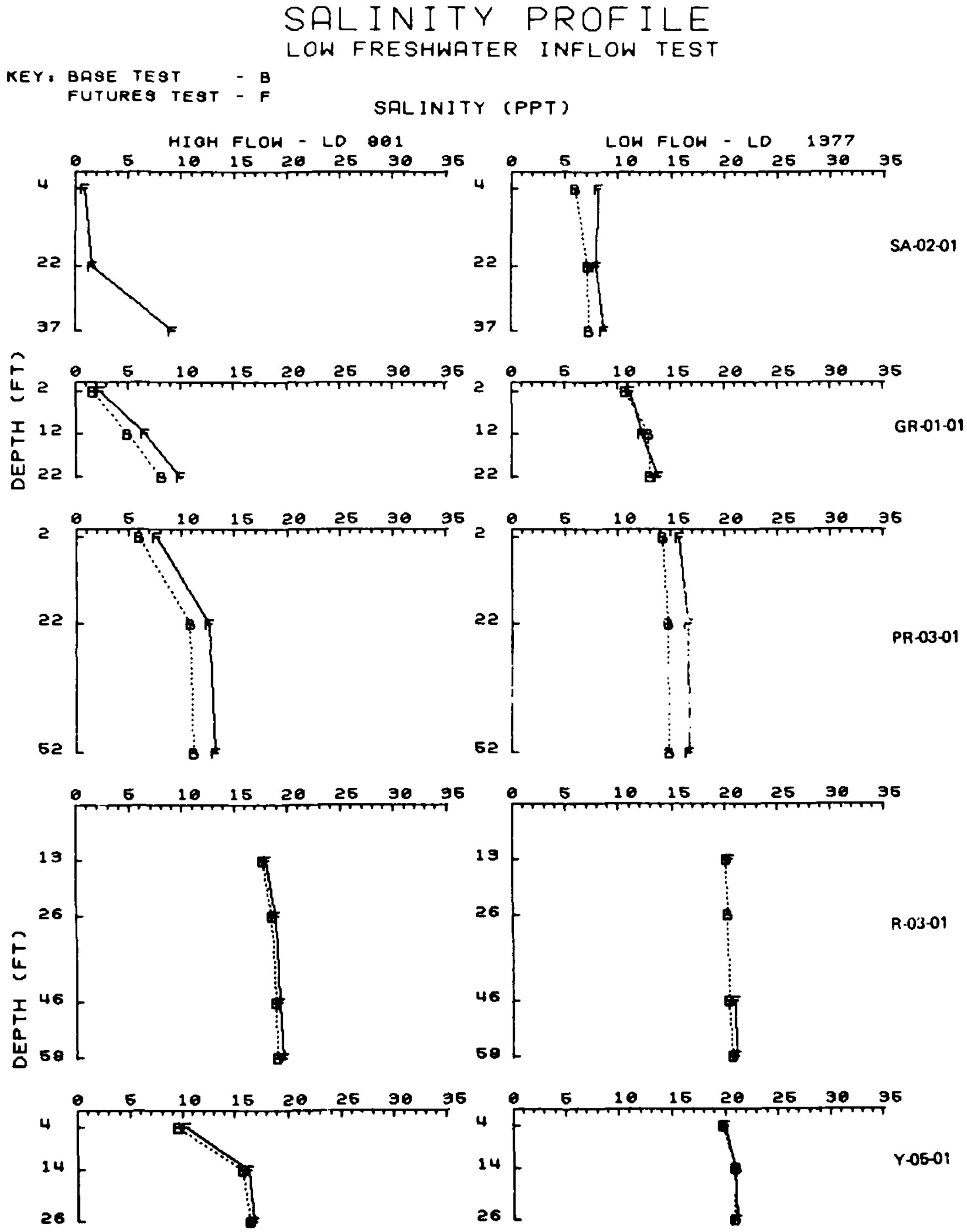


Plate 85. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 901 and 1377

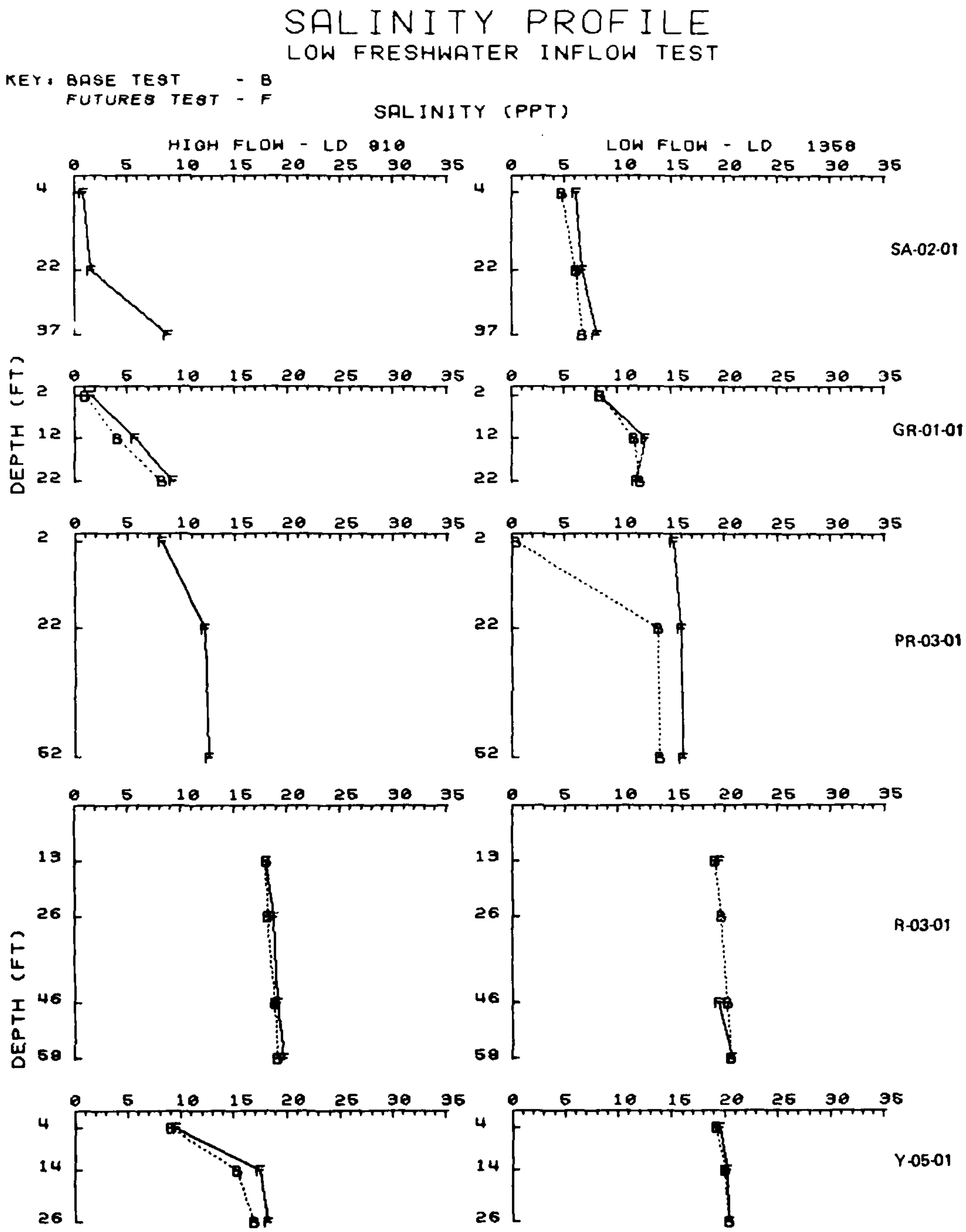


Plate 86. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 910 and 1358

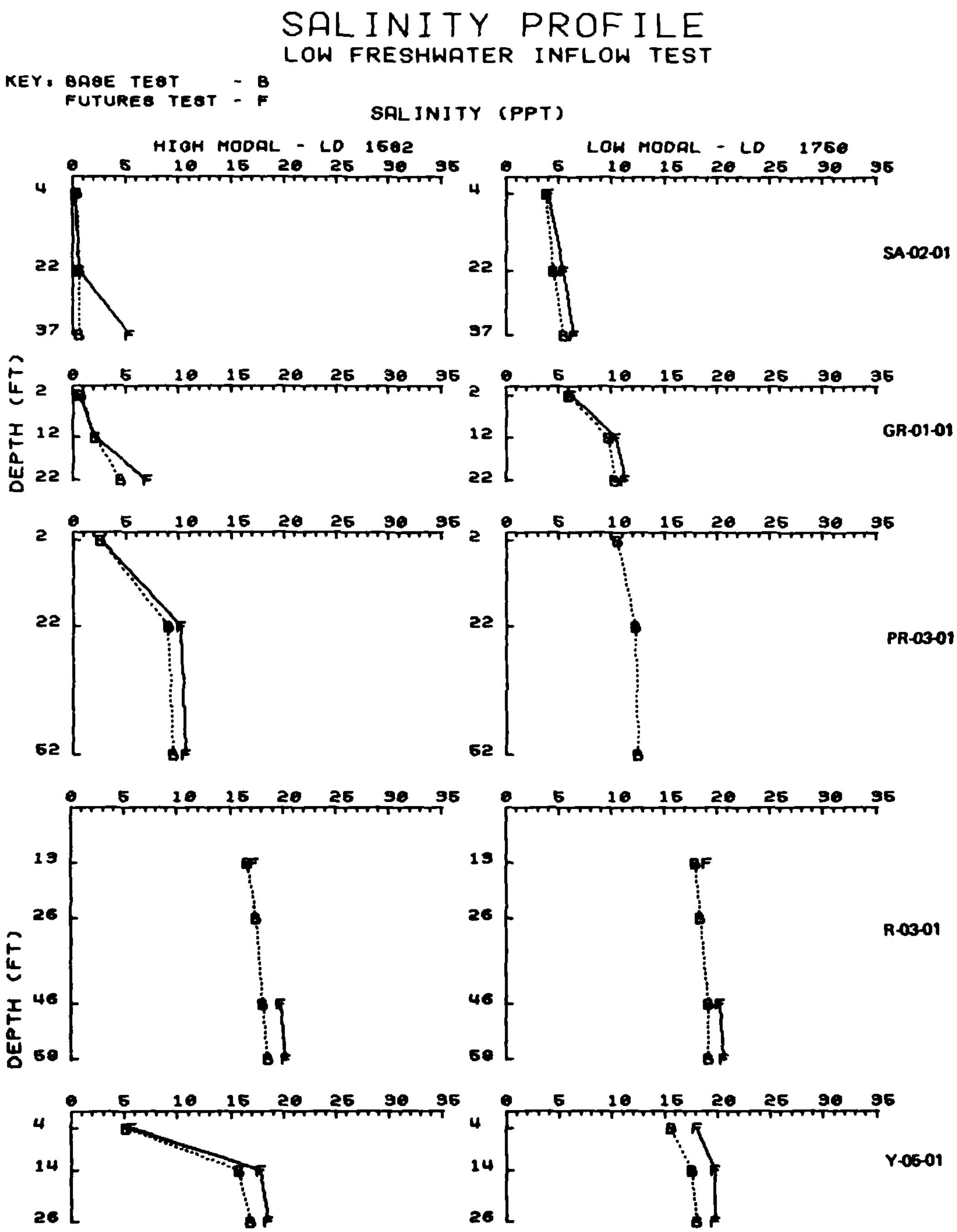


Plate 87. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 1582 and 1750

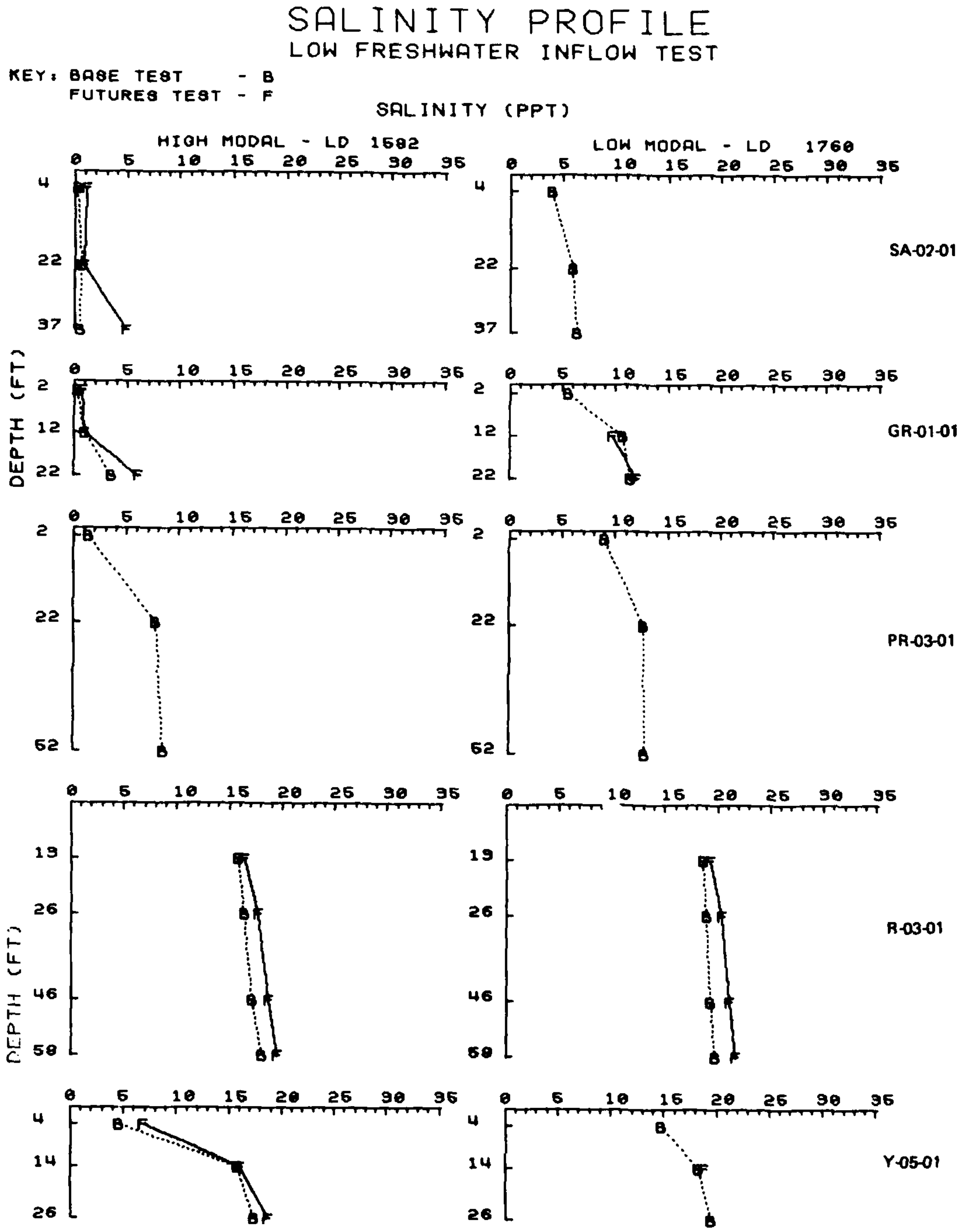


Plate 88. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 1592 and 1760

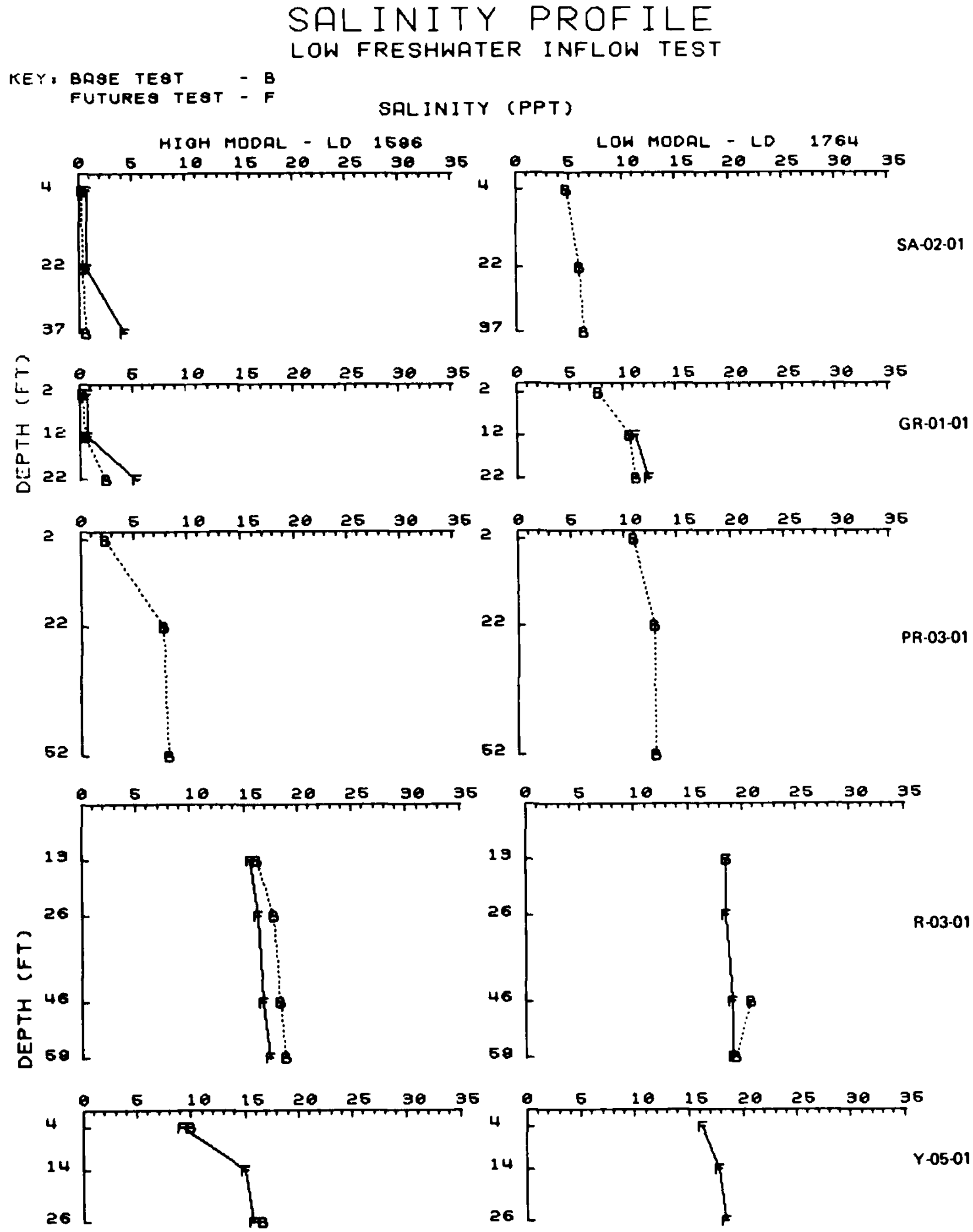


Plate 89. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 1596 and 1764

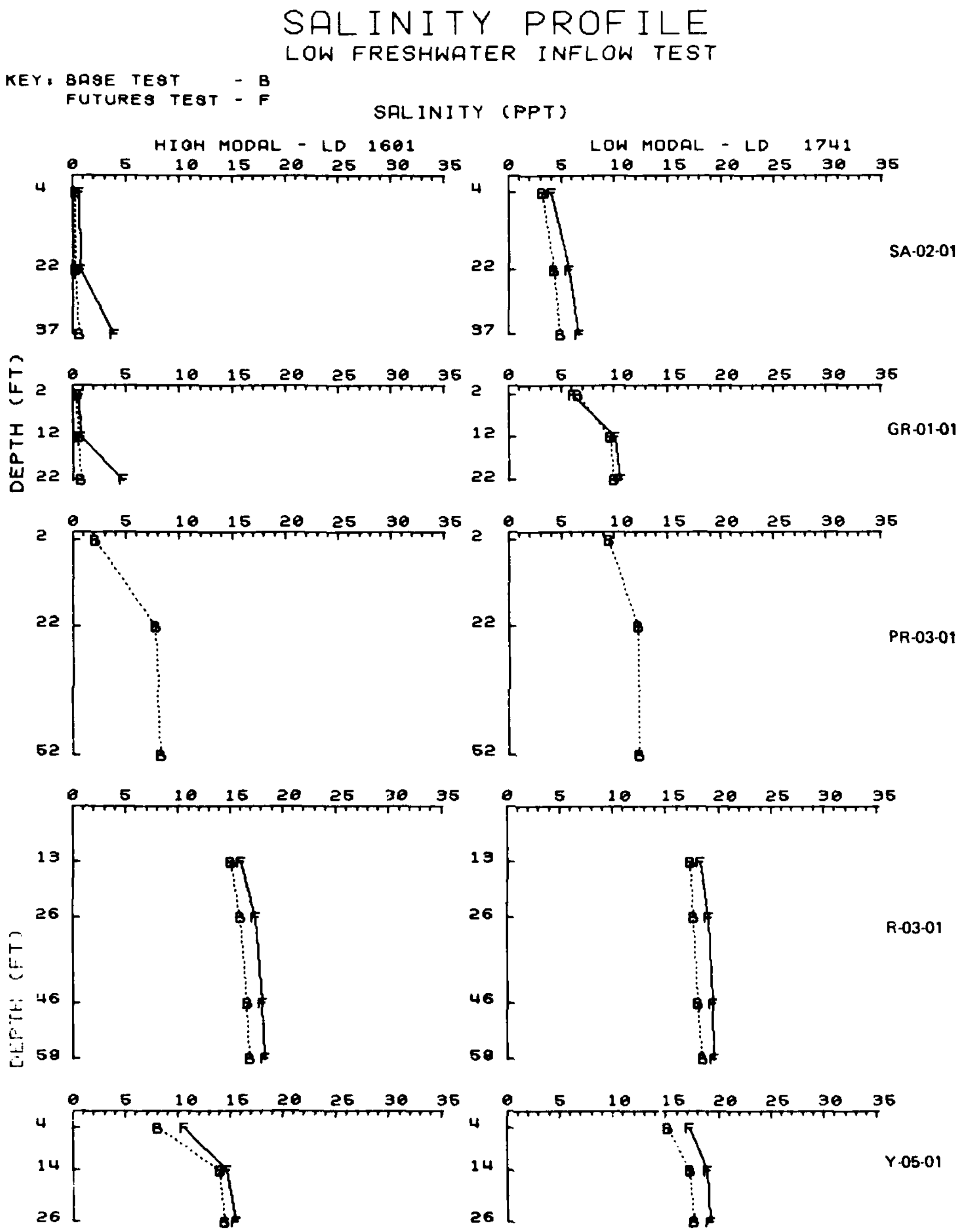


Plate 90. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 1601 and 1741

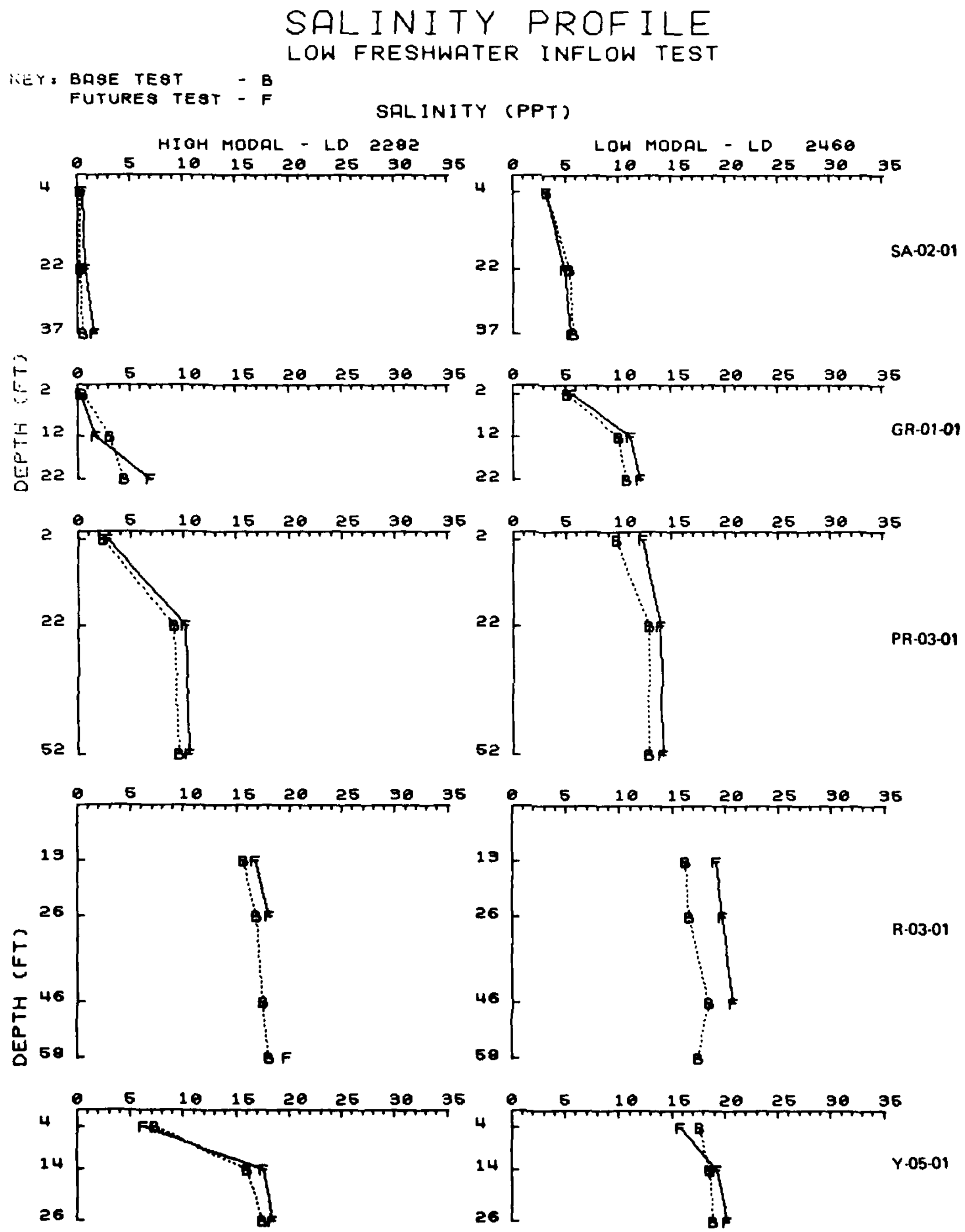


Plate 91. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 2292 and 2460

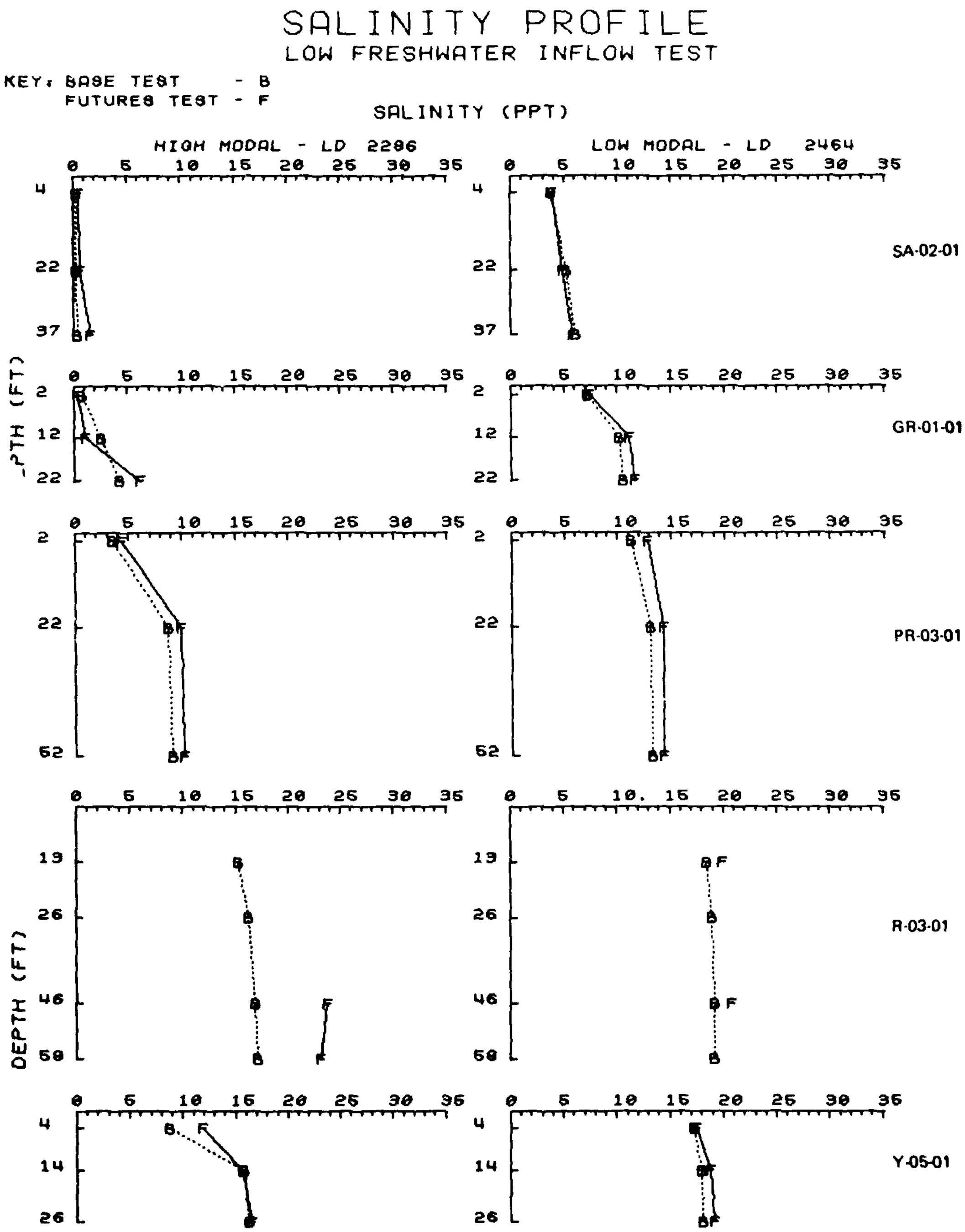


Plate 92. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 2296 and 2464

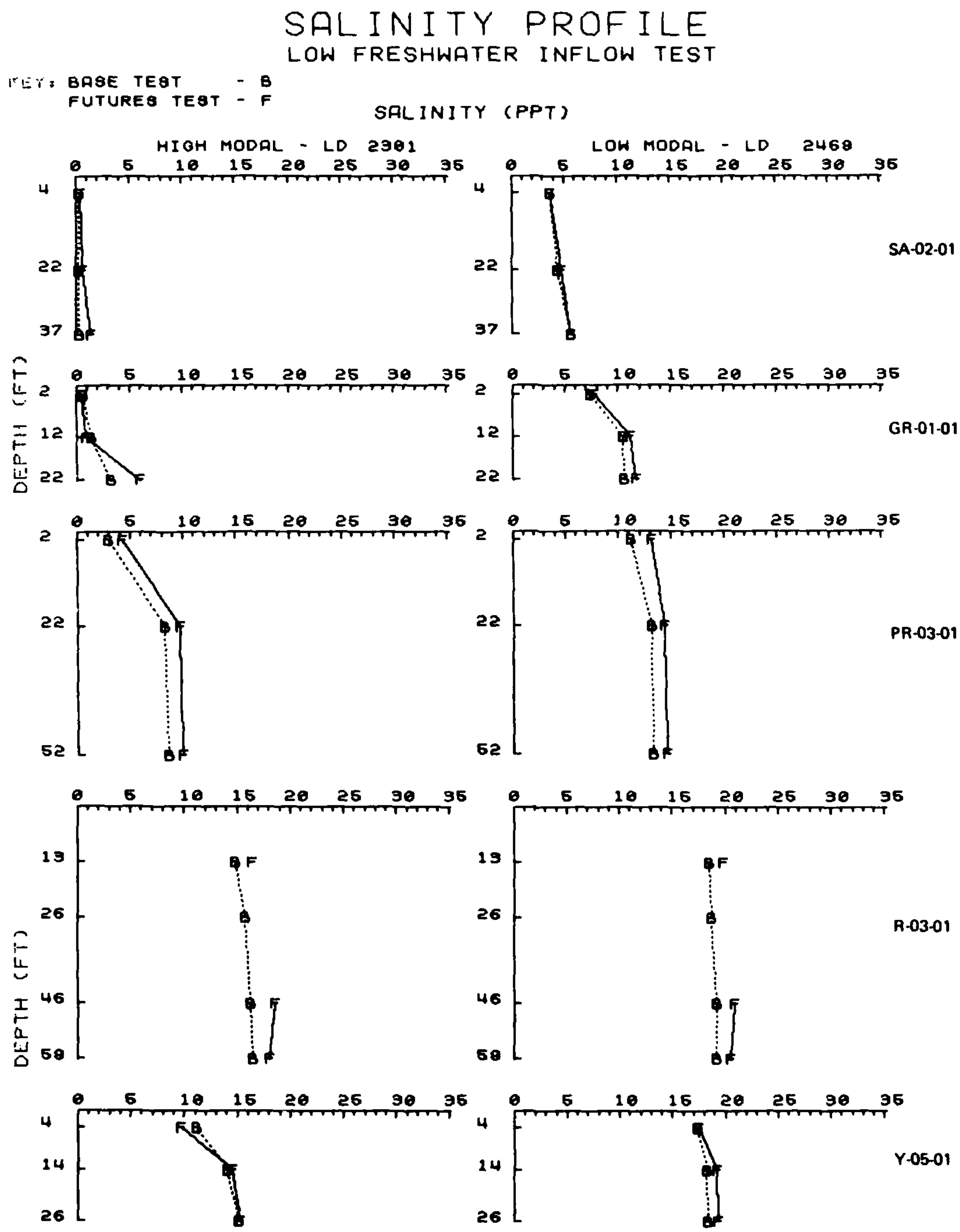


Plate 93. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 2901 and 2469

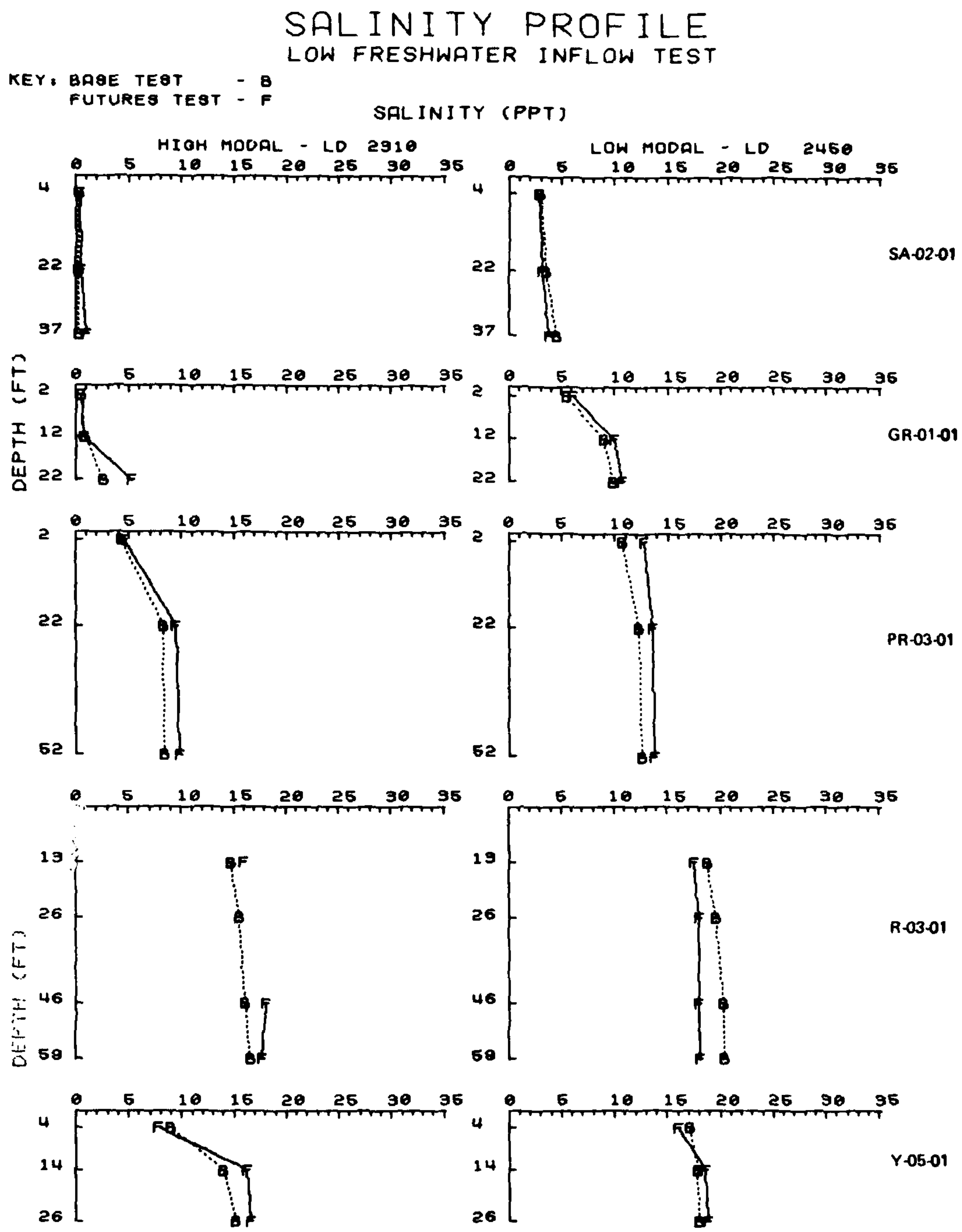


Plate 94. Salinity profiles, sta SA-02-01, GR-01-01, PR-03-01, R-03-01, and Y-05-01, lunar days 2910 and 2450

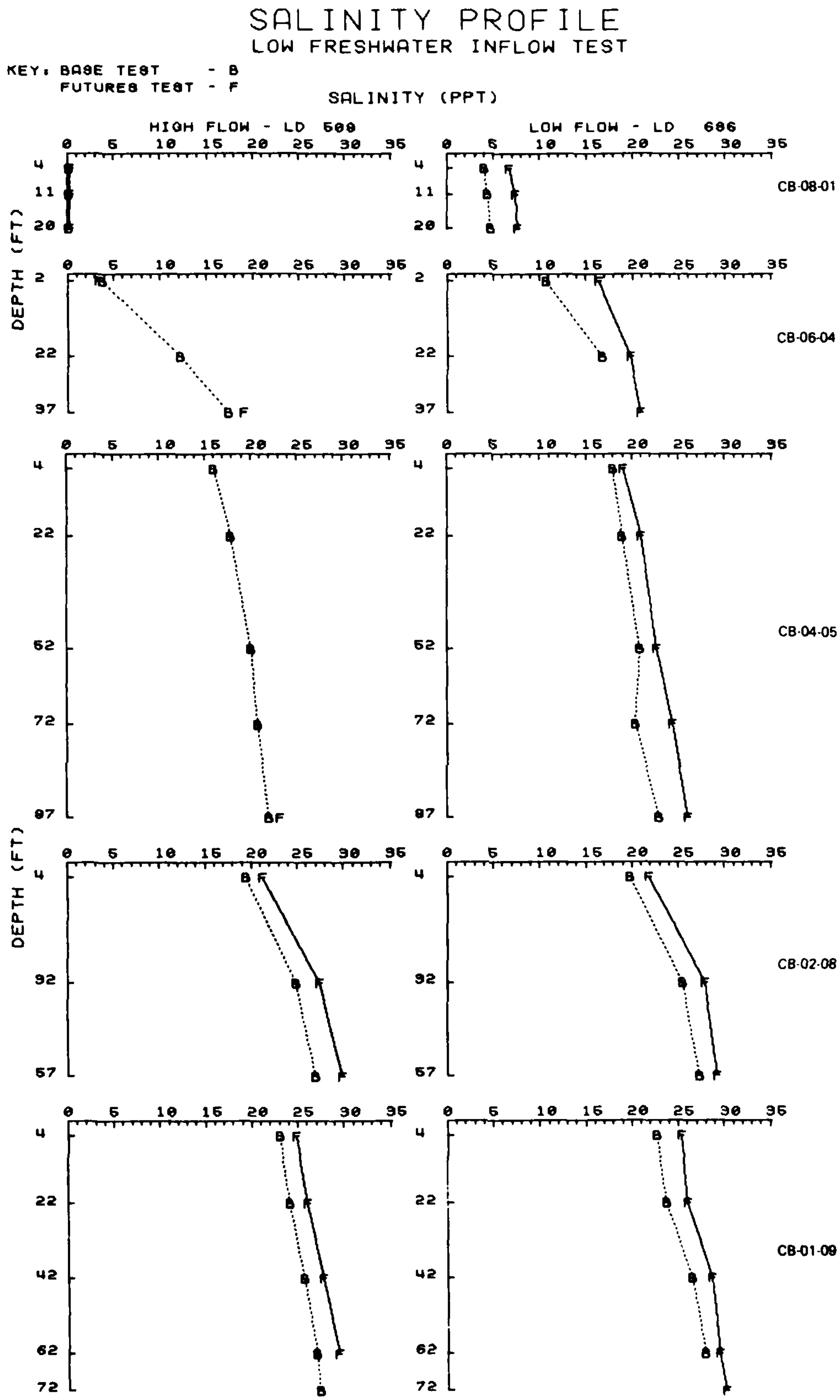


Plate 95. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 509 and 686

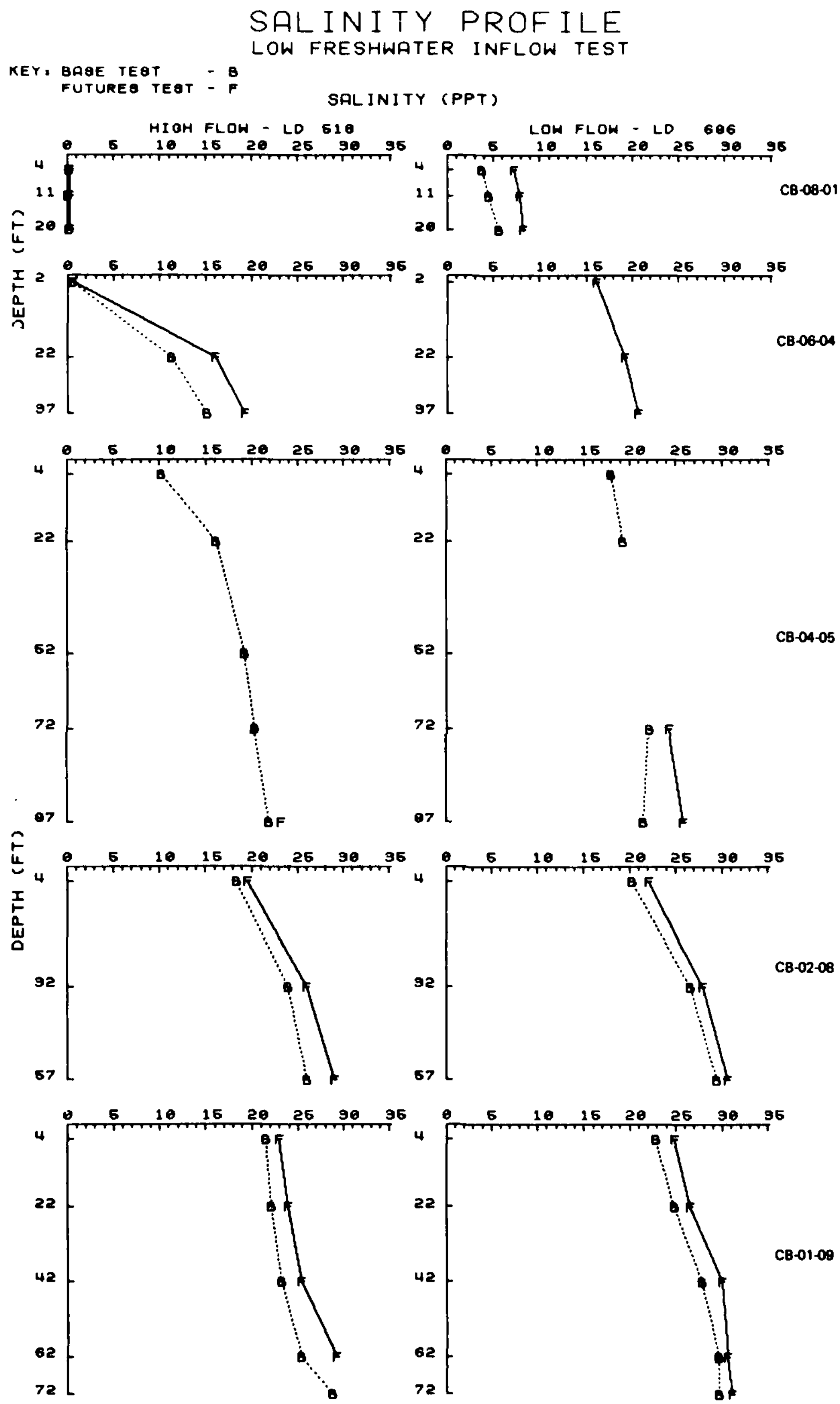


Plate 96. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 518 and 696

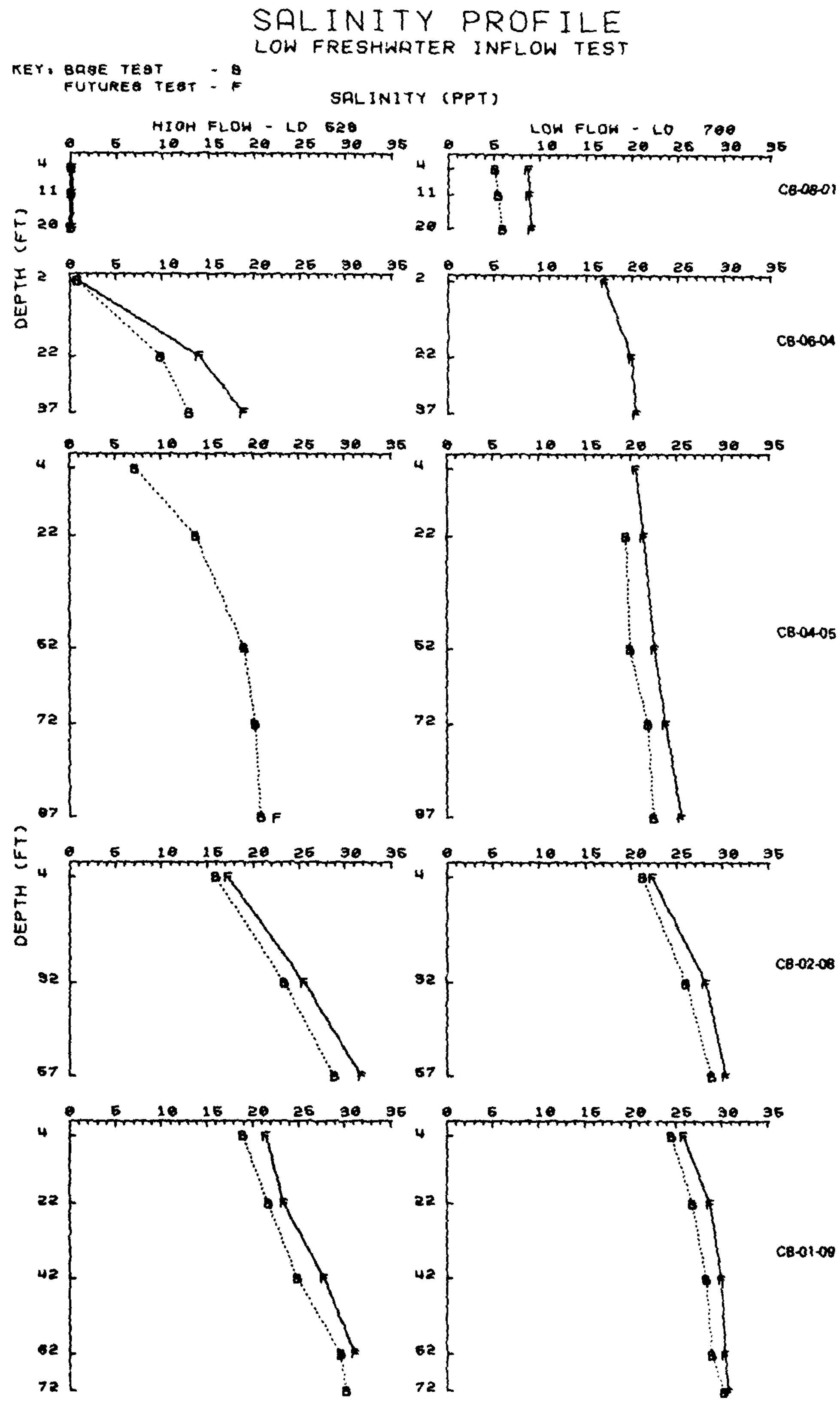


Plate 97. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 528 and 700

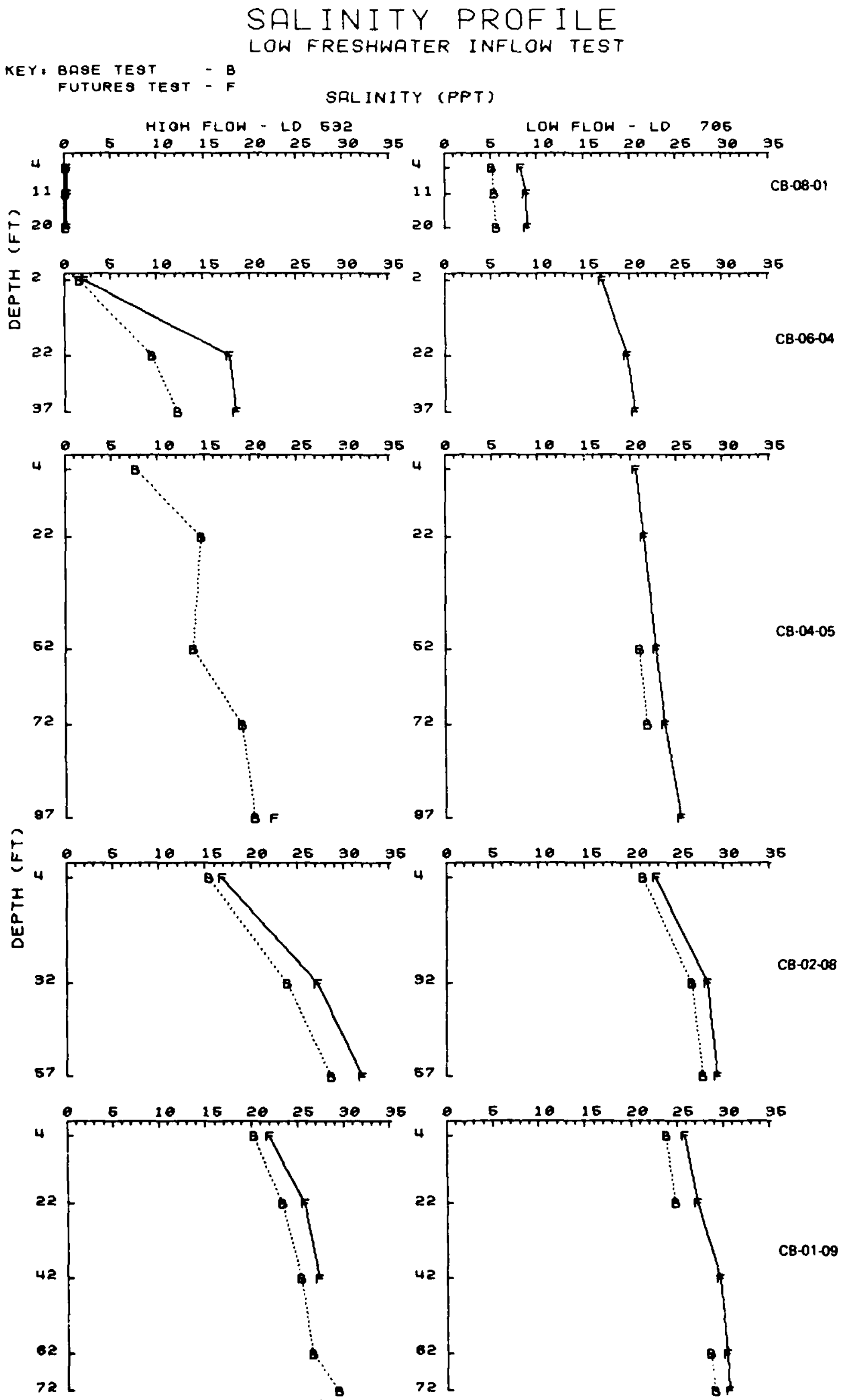


Plate 98. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 532 and 705

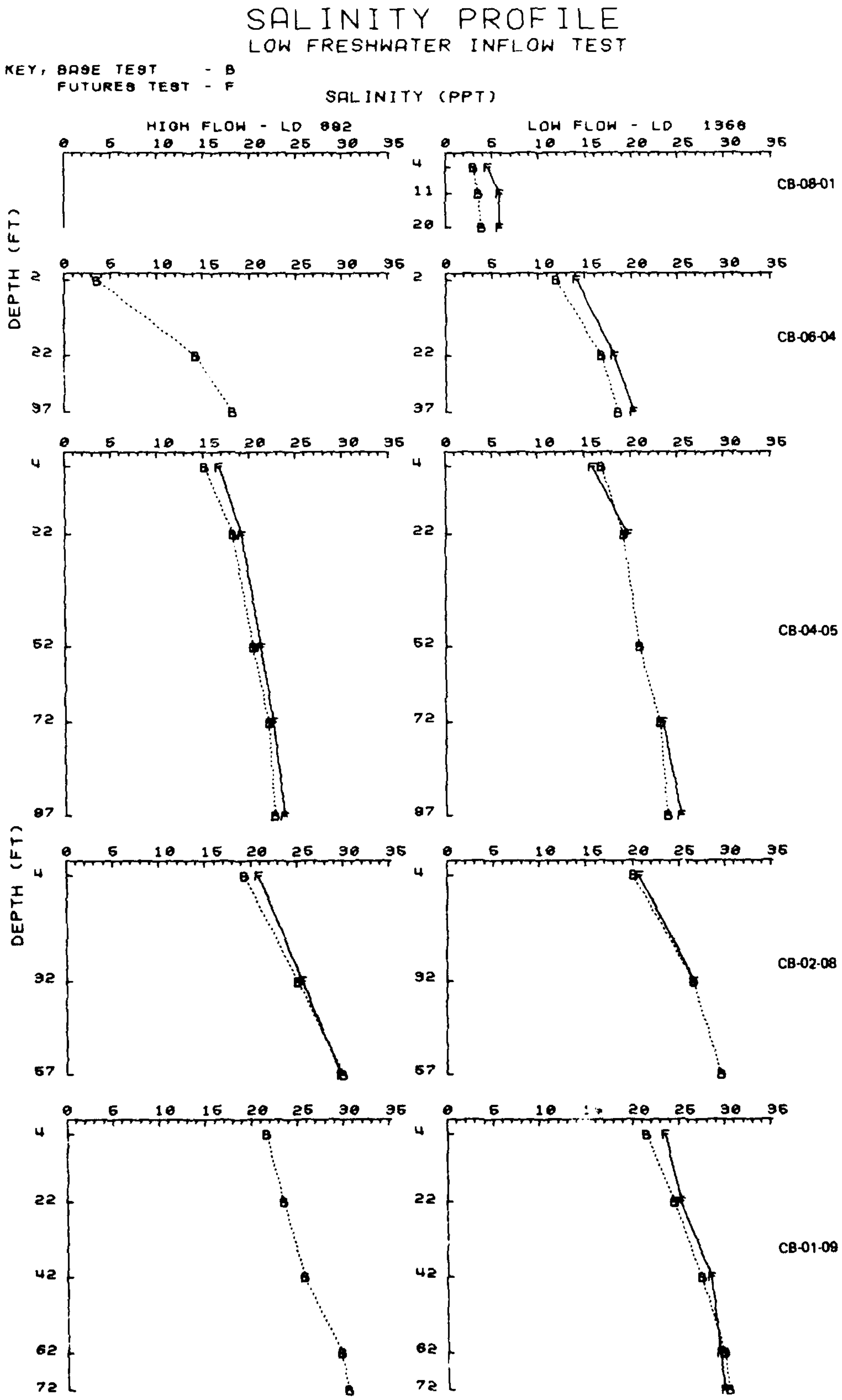


Plate 99. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 892 and 1368

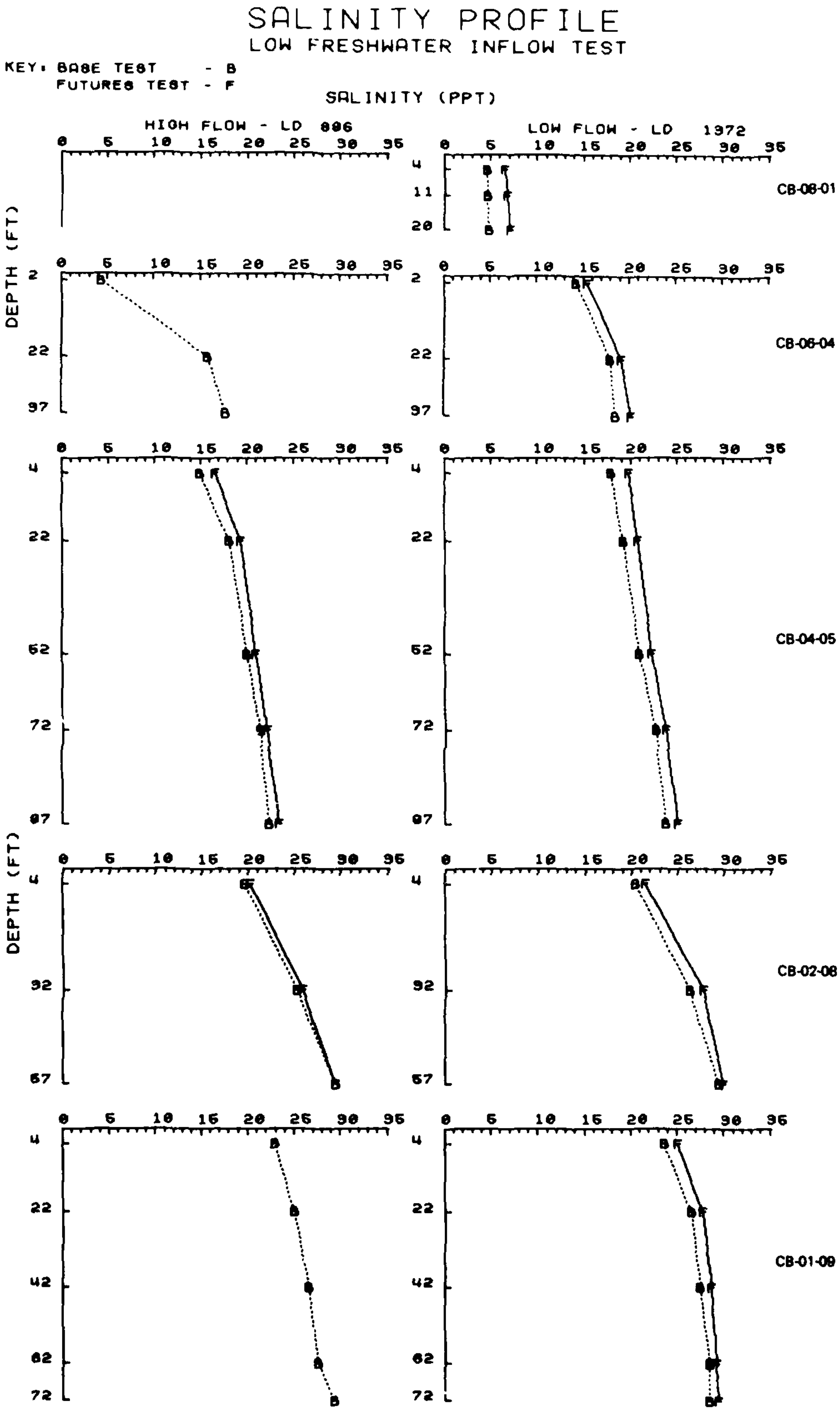


Plate 100. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 896 and 1372

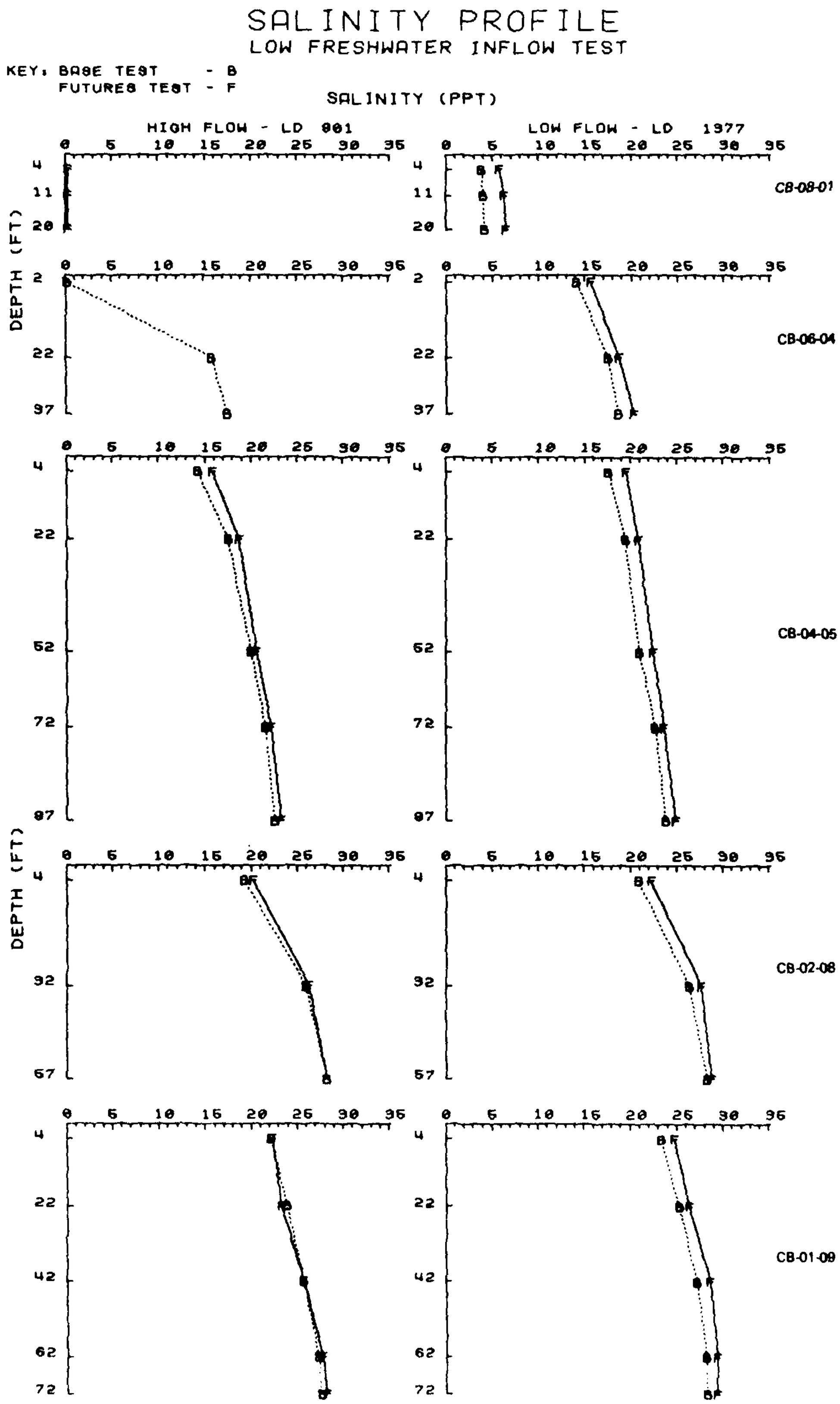


Plate 101. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 901 and 1377

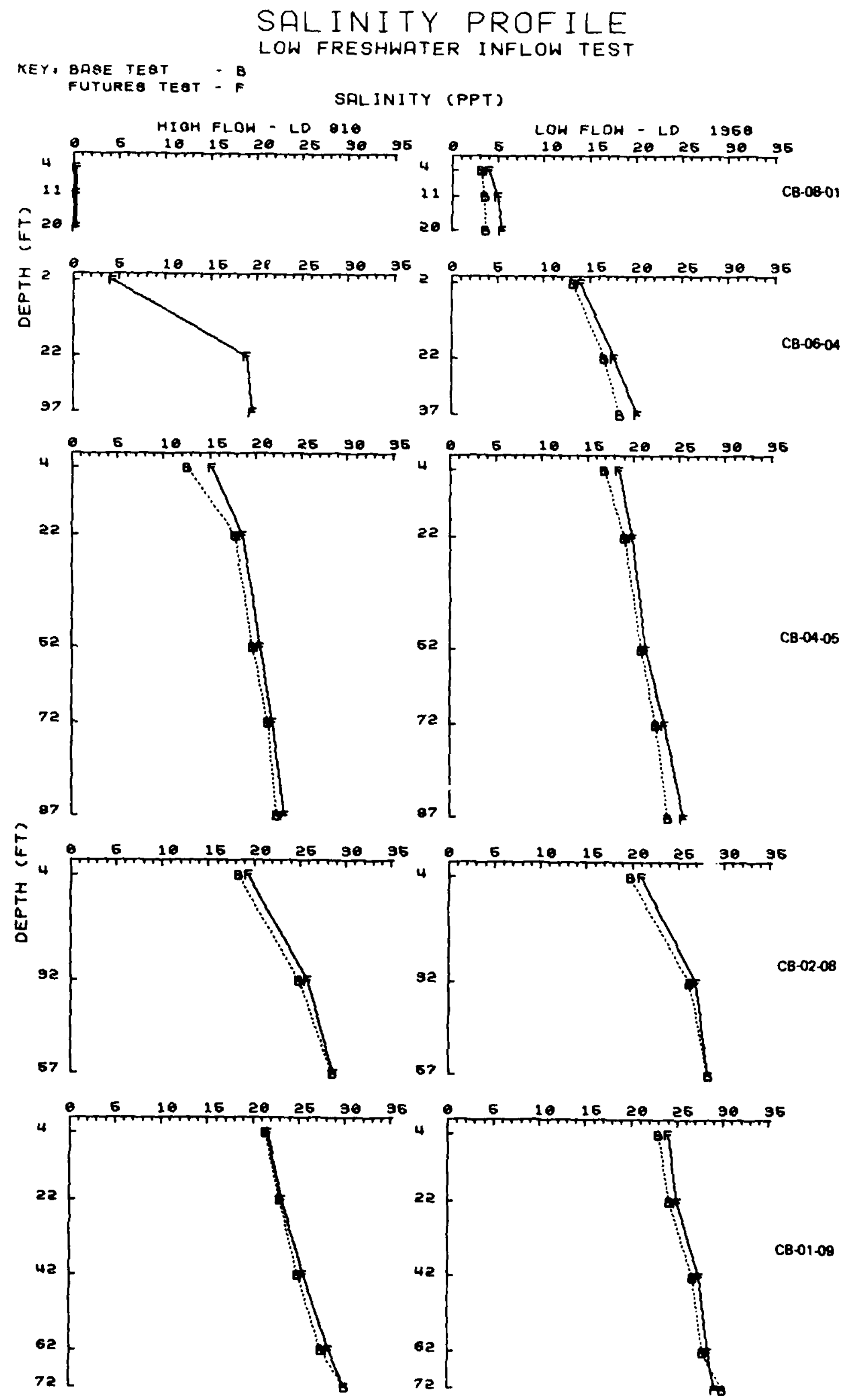


Plate 102. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 910 and 1358

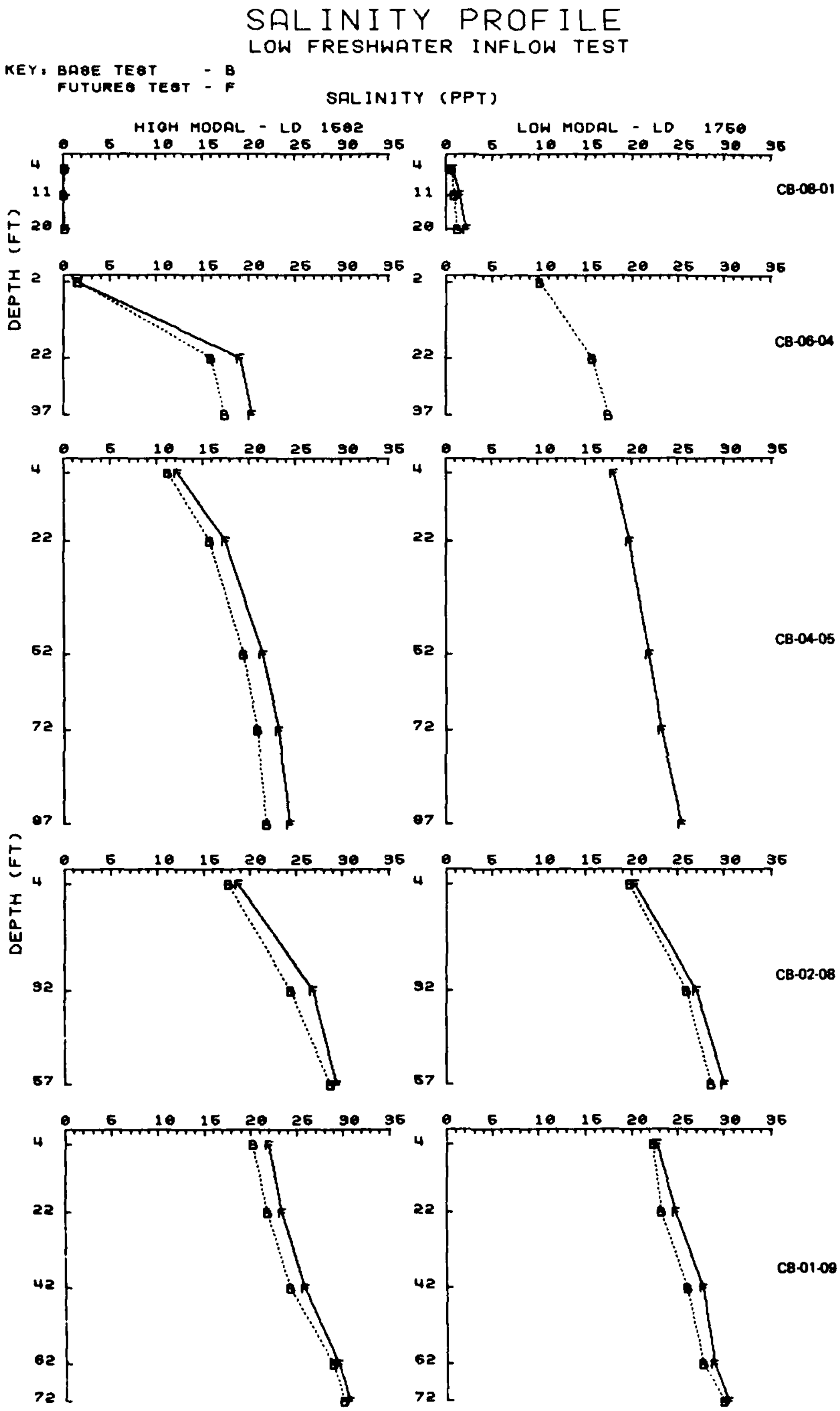


Plate 103. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 1582 and 1750

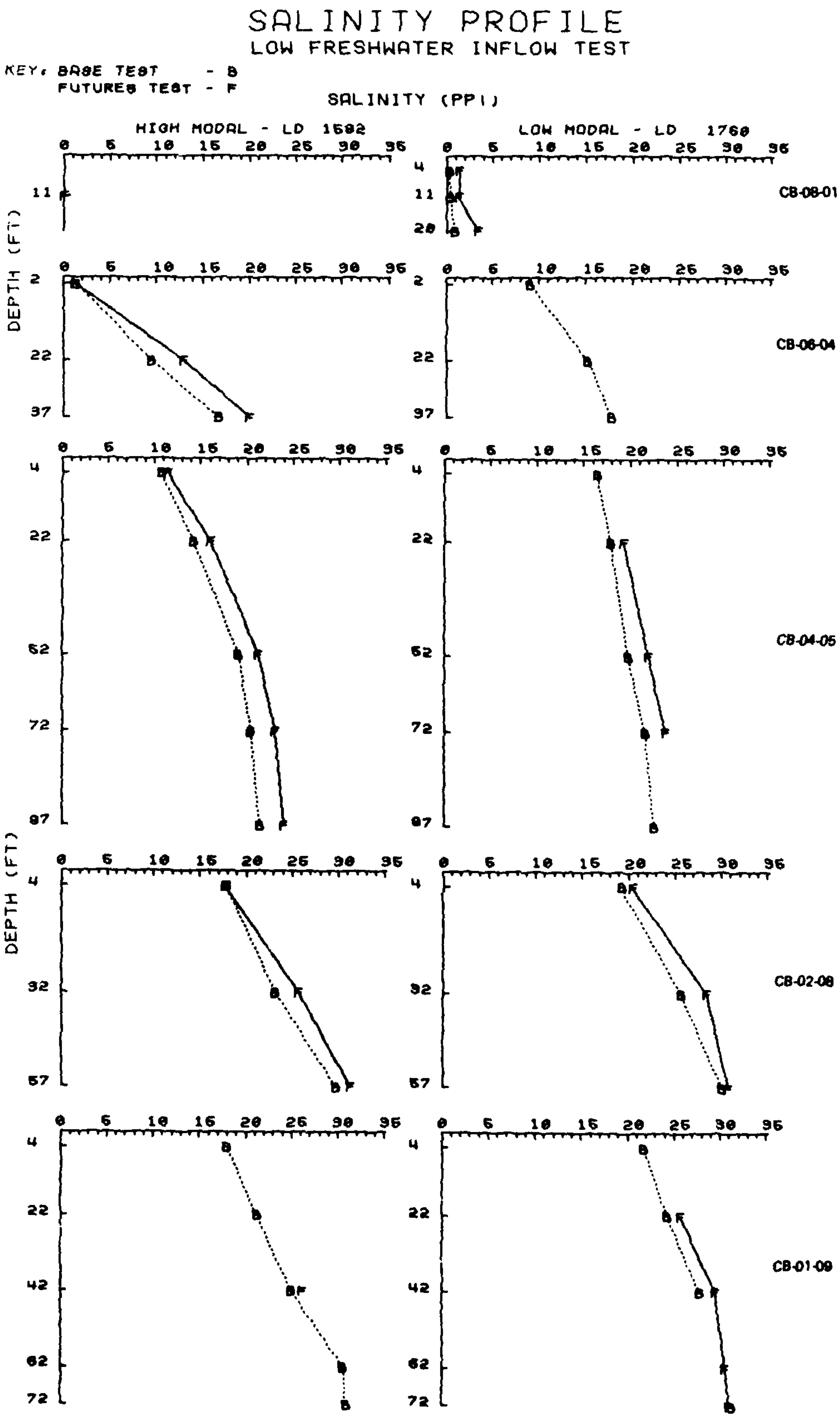


Plate 104. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 1592 and 1760

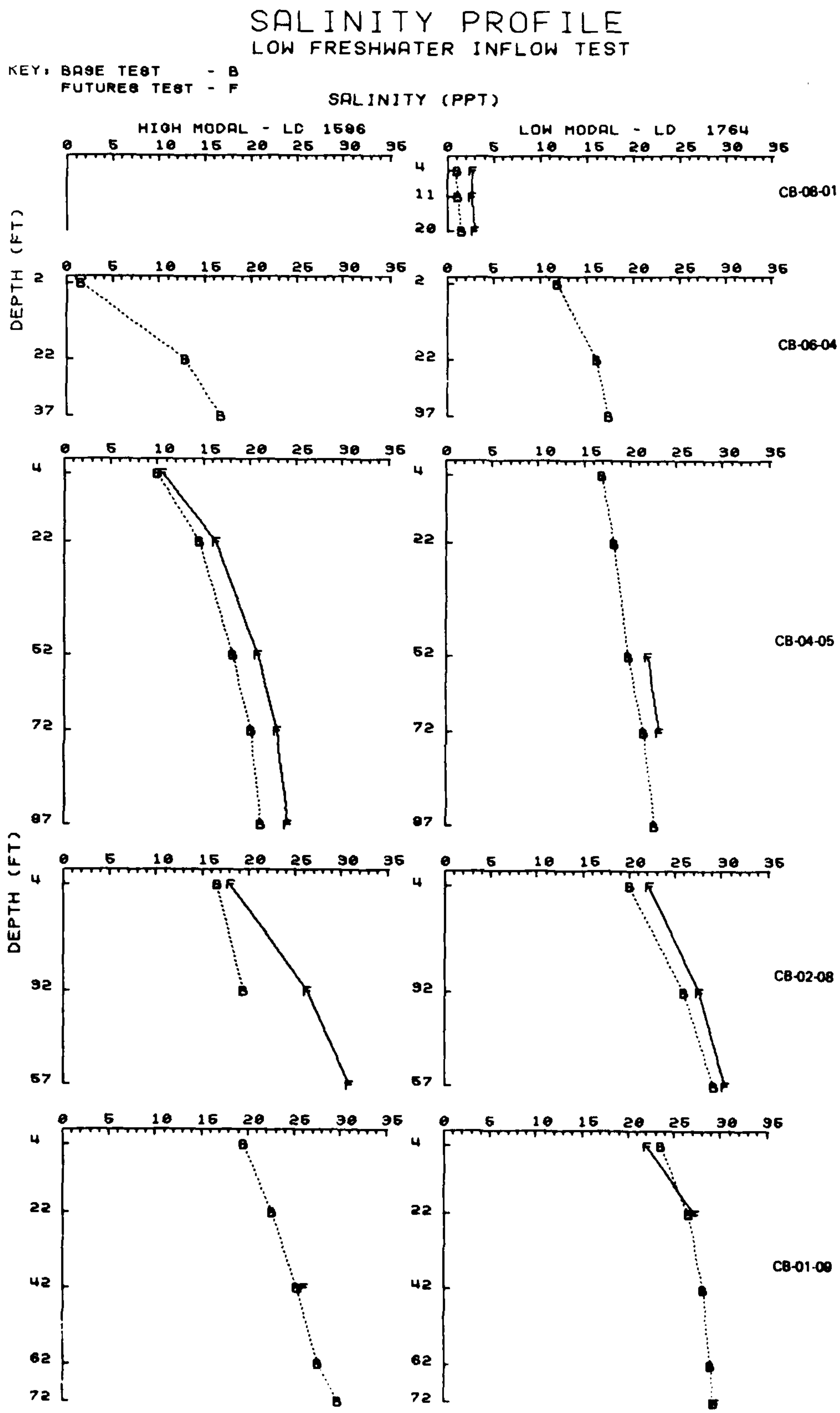


Plate 105. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 1596 and 1764

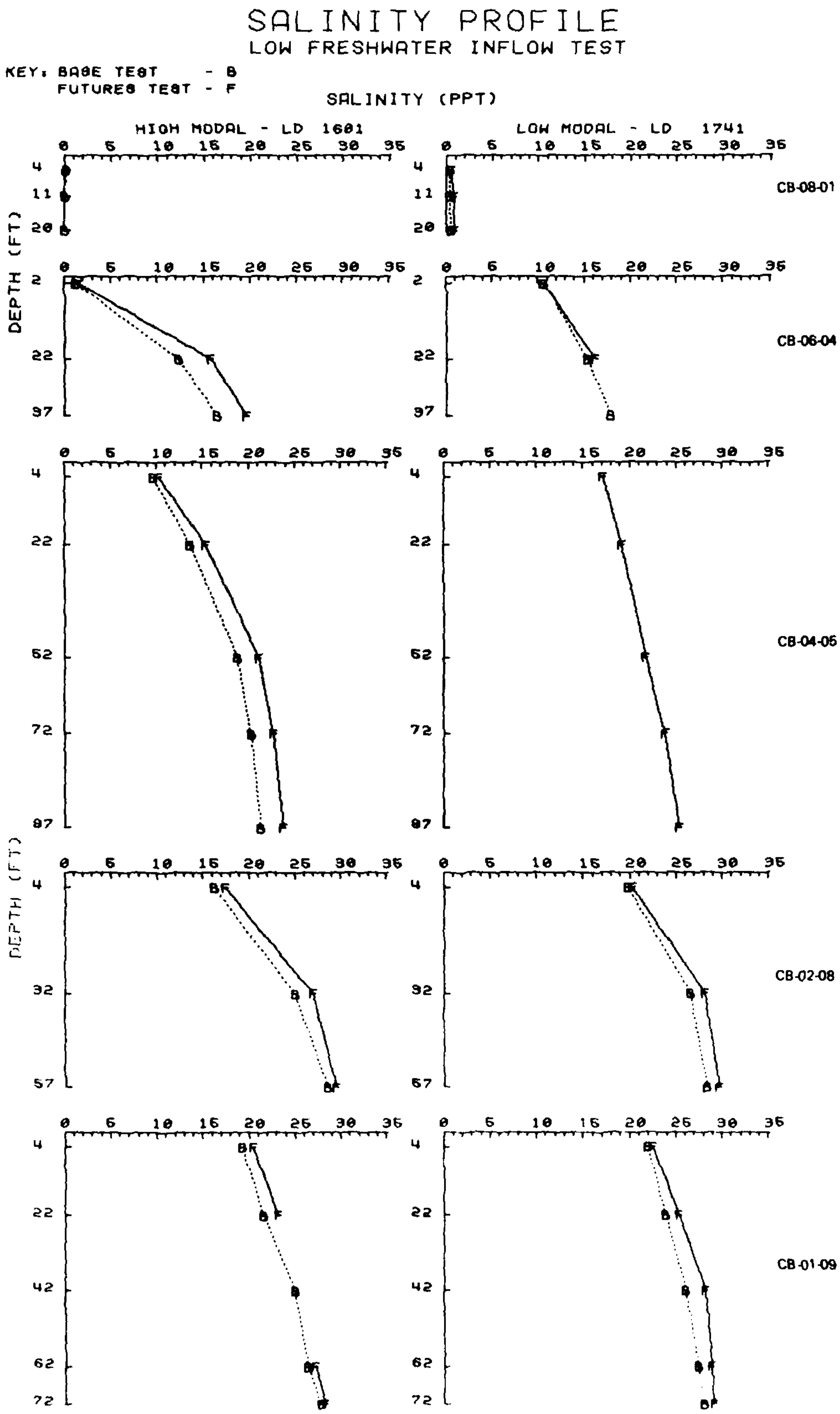


Plate 106. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 1681 and 1741

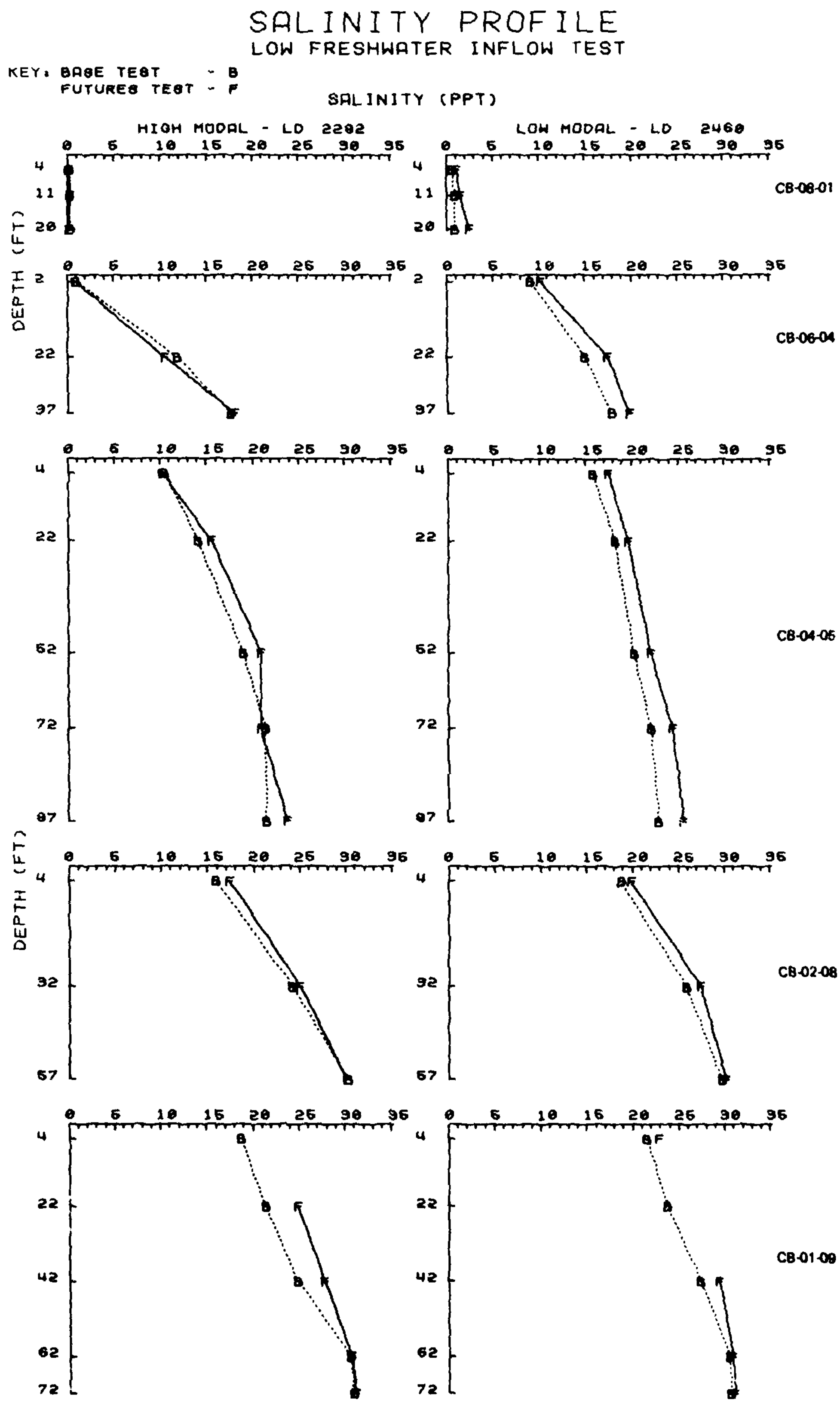


Plate 107. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 2292 and 2460

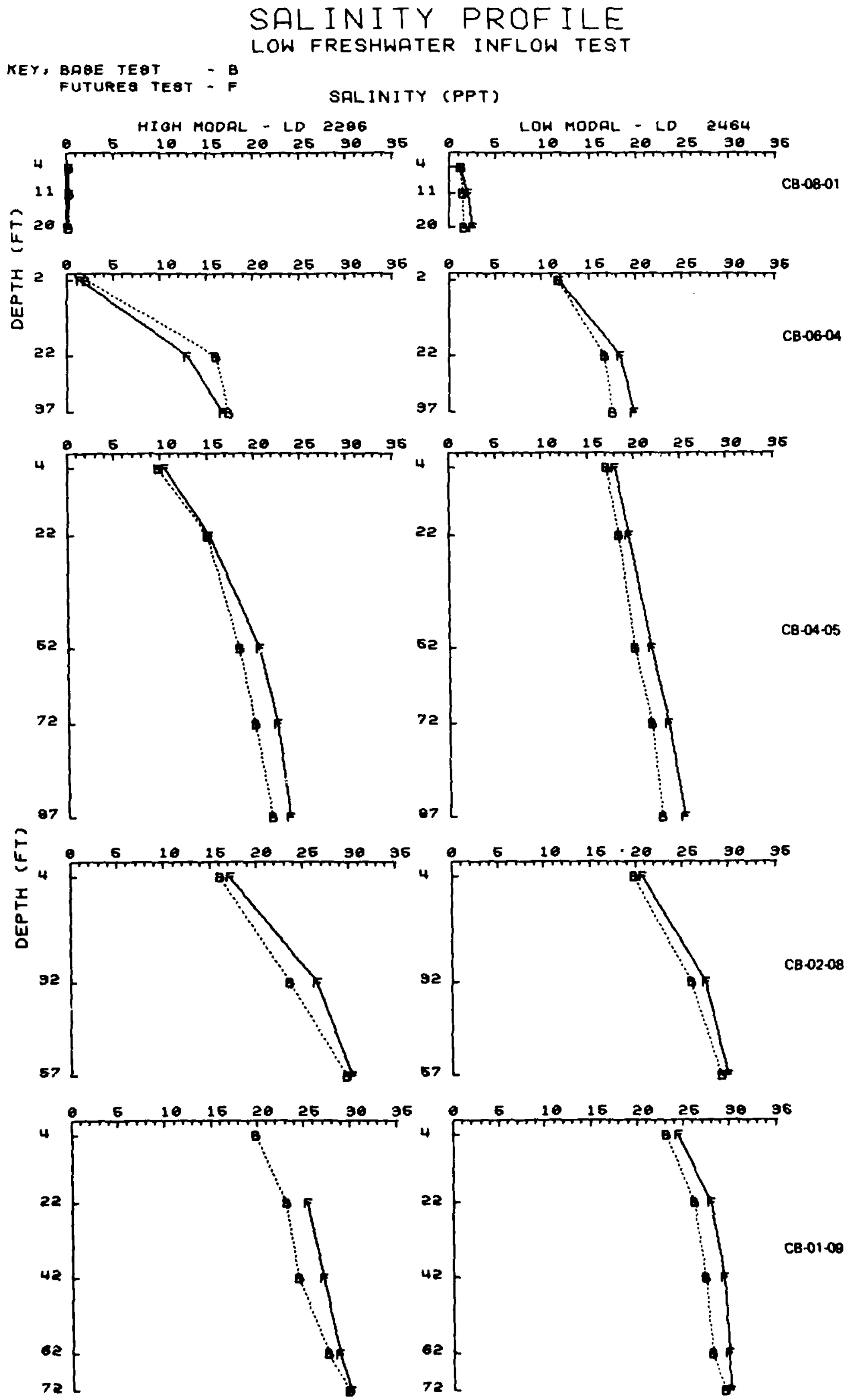


Plate 108. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 2296 and 2464

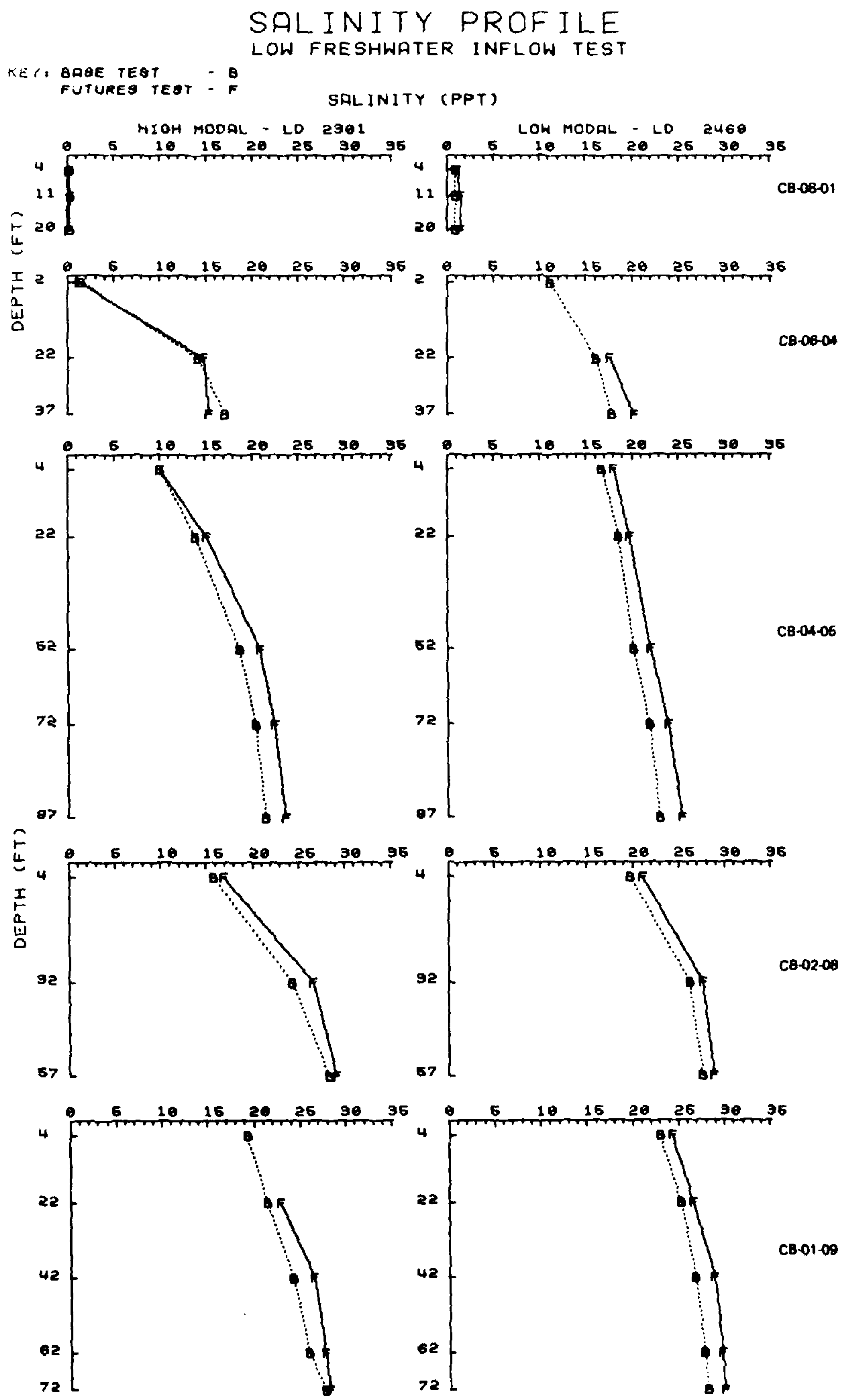


Plate 109. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 2301 and 2469

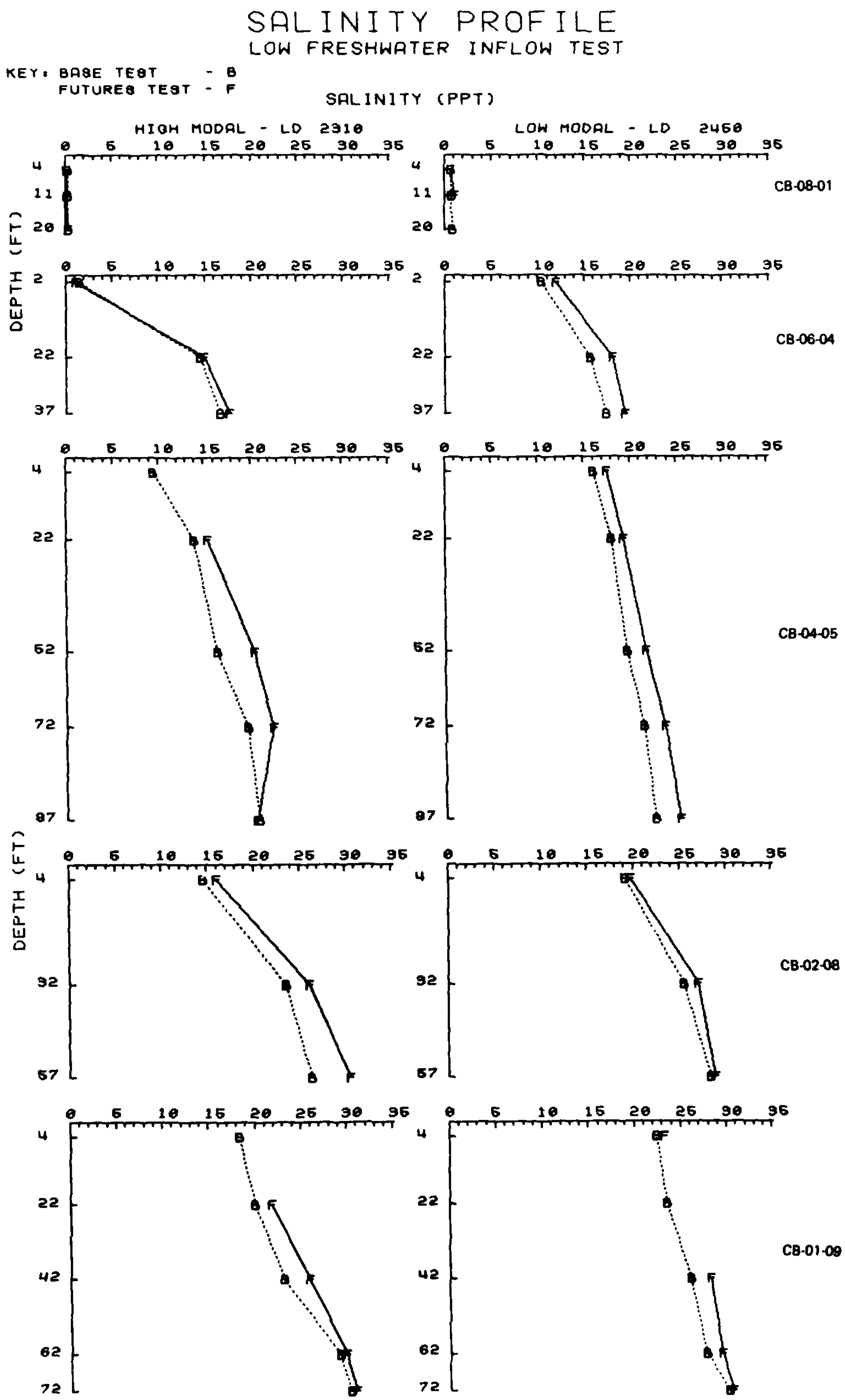


Plate 110. Salinity profiles, sta CB-08-01, CB-06-04, CB-04-05, CB-02-08, and CB-01-09, lunar days 2310 and 2450

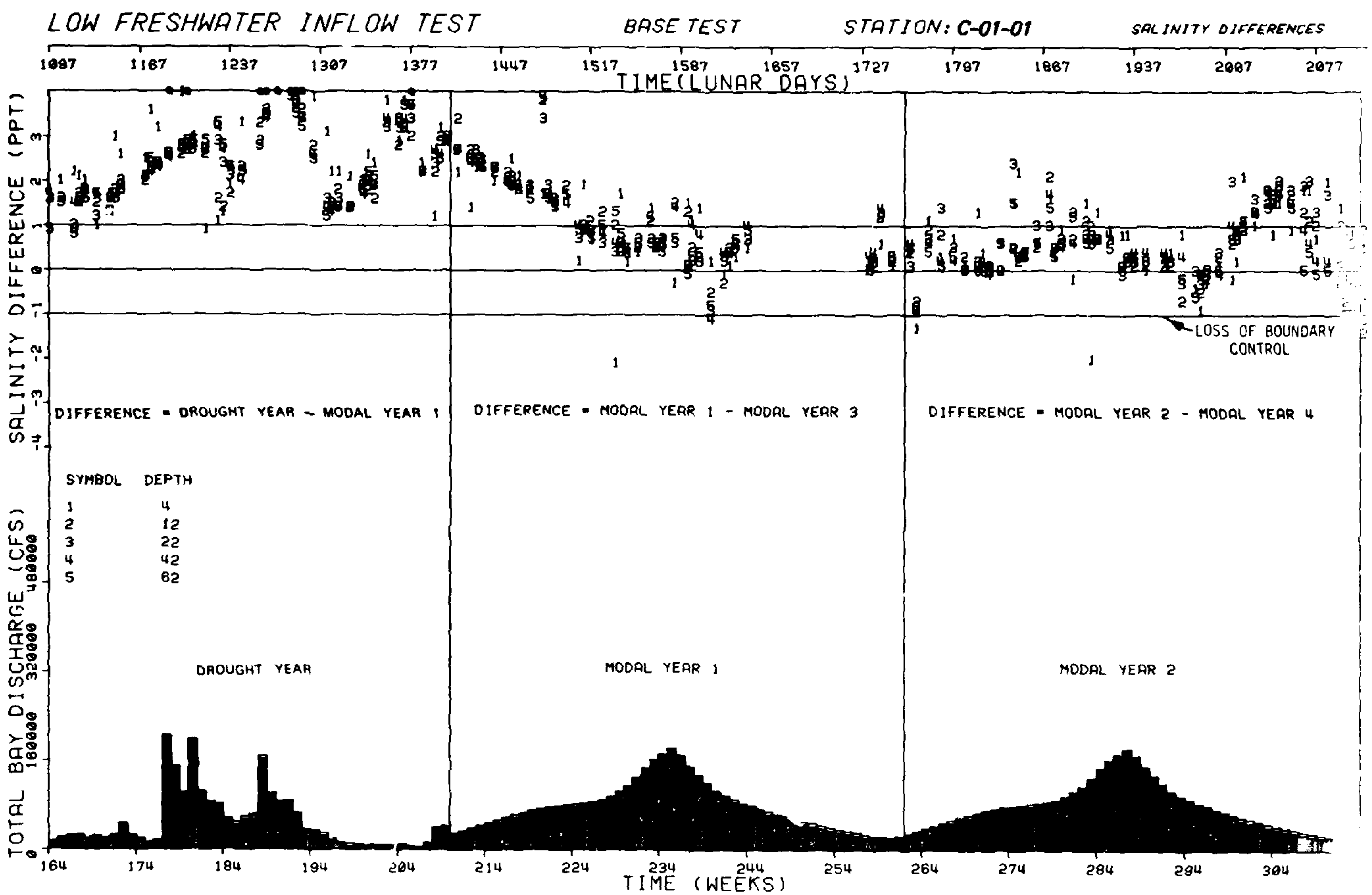


Plate 111. Dynamic normalcy plots, Base Test, sta C-01-01

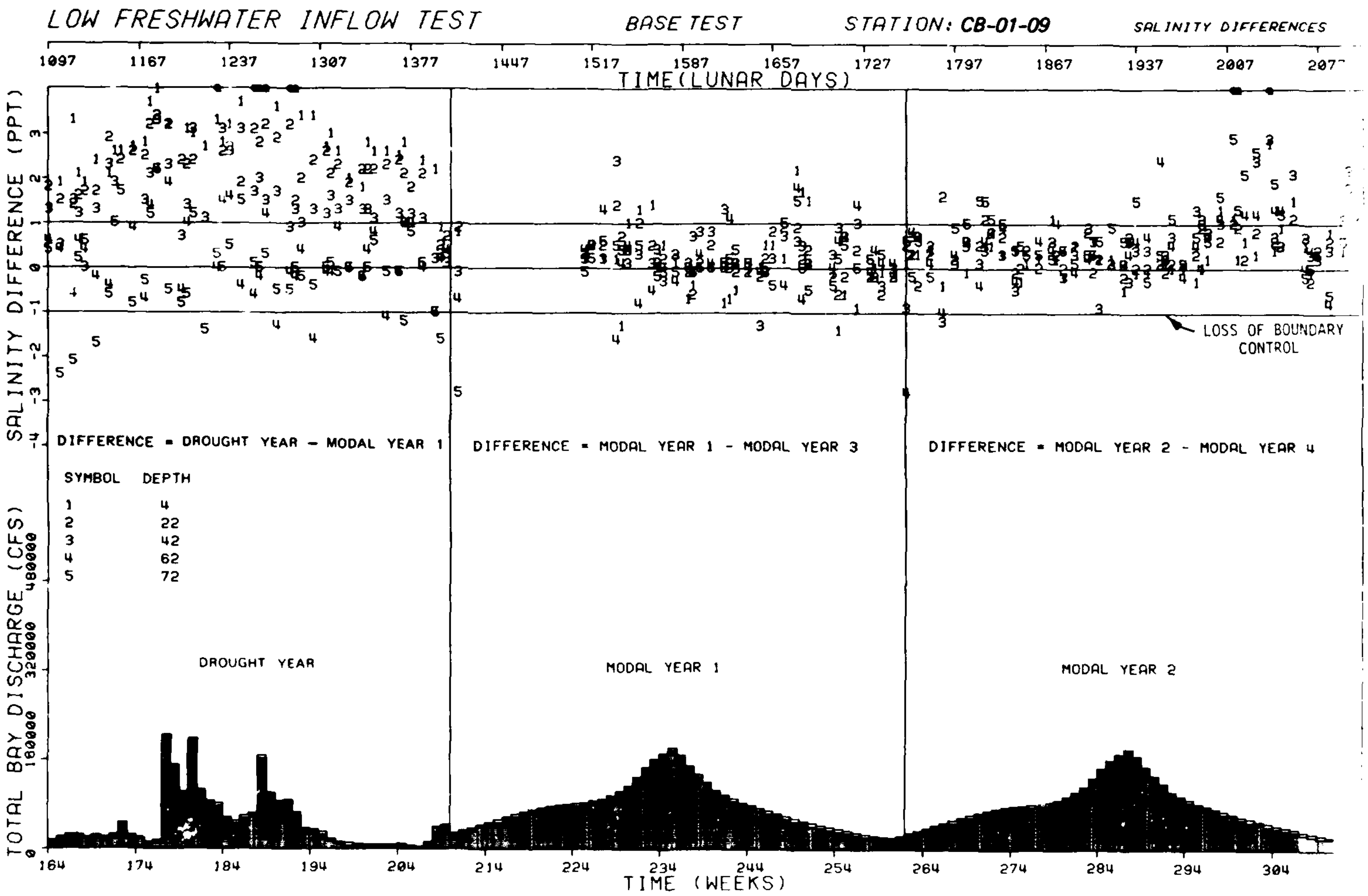


Plate 112. Dynamic normalcy plots, Base Test, sta CB-01-09

AD-A112 215 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 8/8
LOW FRESHWATER INFLOW STUDY. CHESAPEAKE BAY HYDRAULIC MODEL INV--ETC(U)
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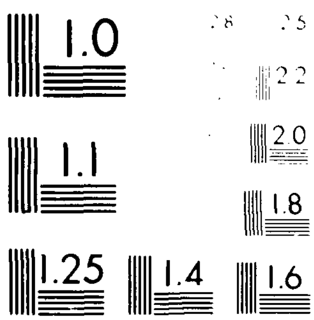
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2.0
1.1
1.8
1.25
1.4
1.6

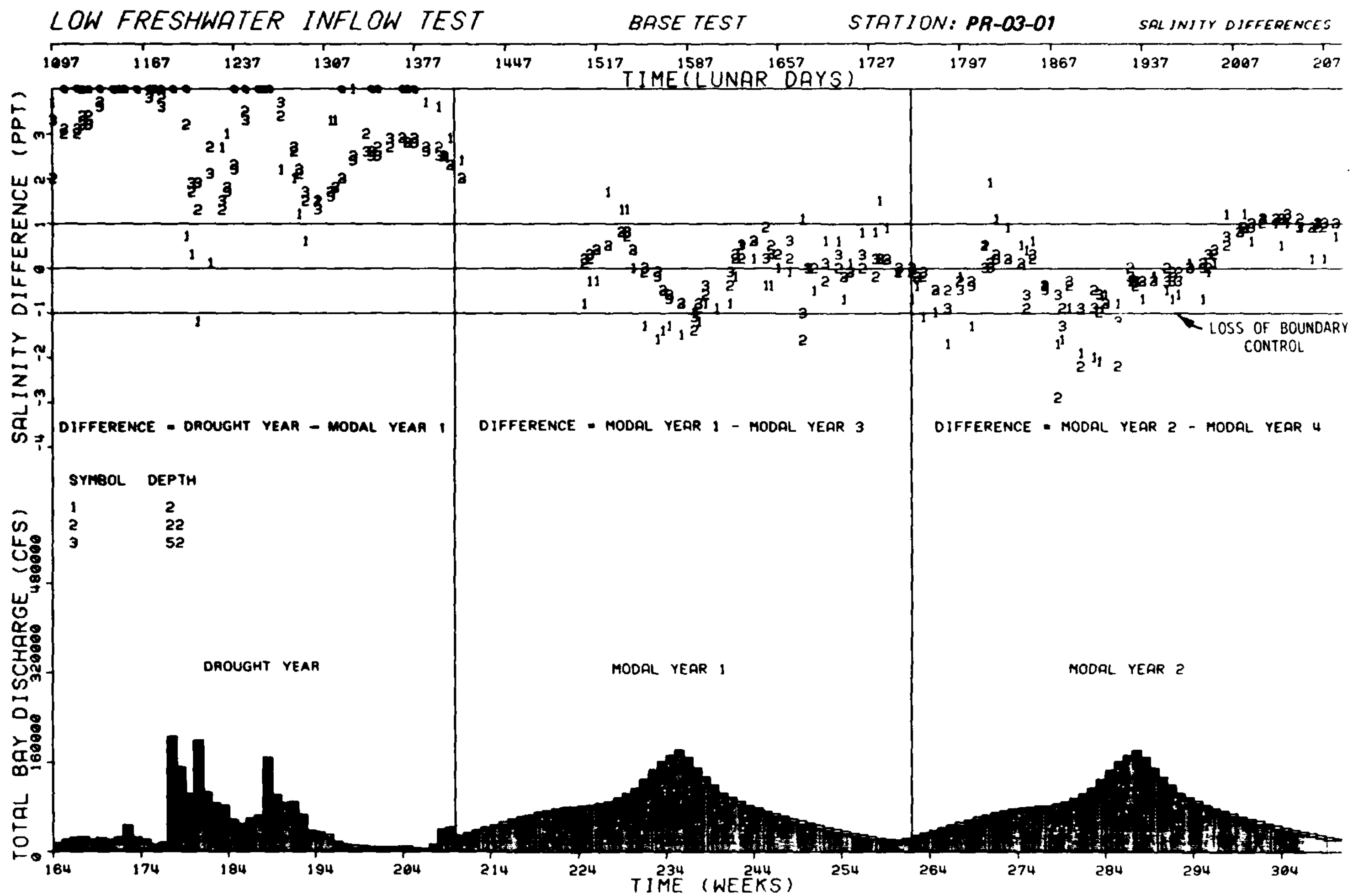

Plate 113. Dynamic normalcy plots, Base Test, sta PR-03-01

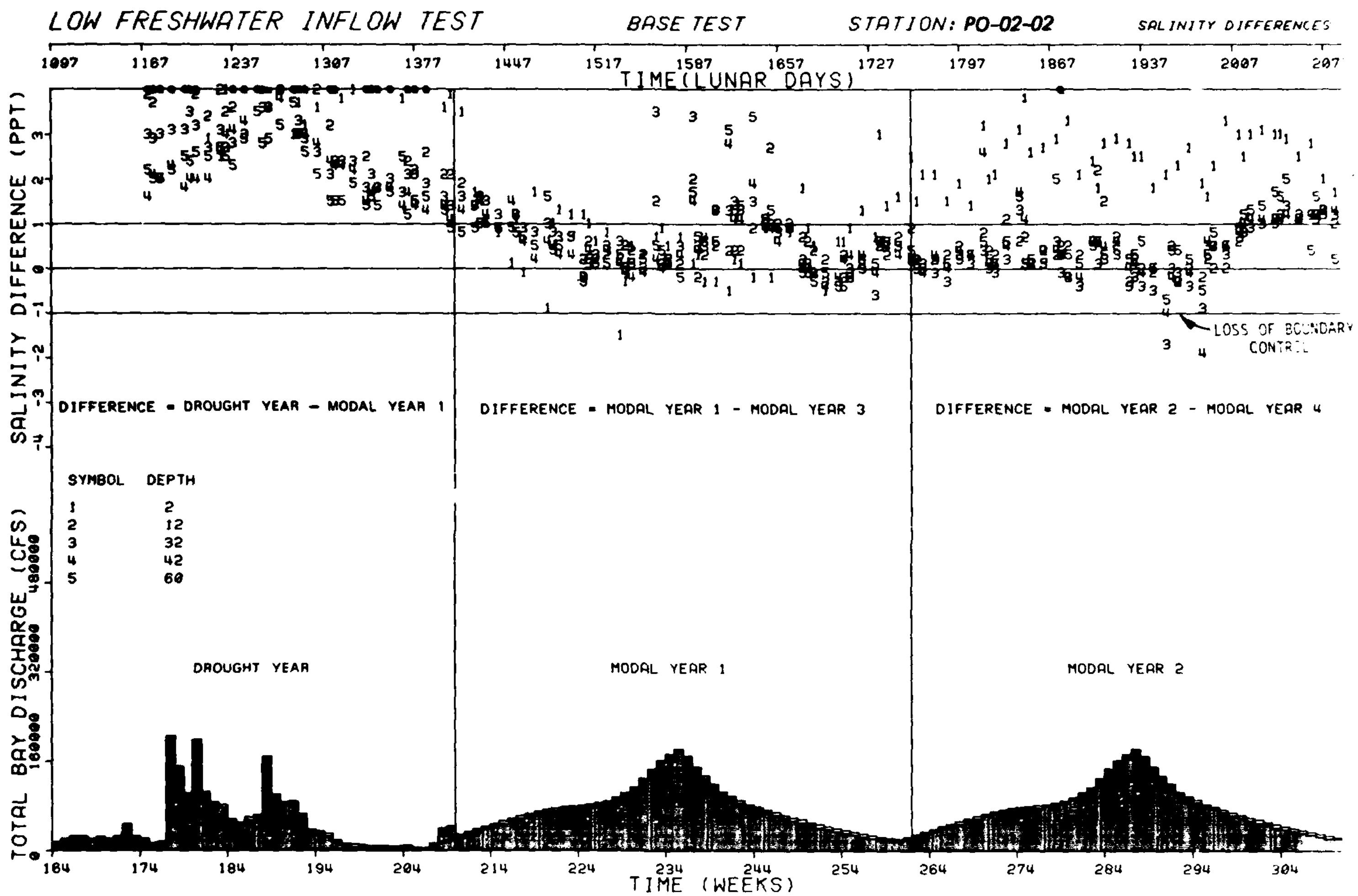

Plate 114. Dynamic normalcy plots, Base Test, sta PO-02-02

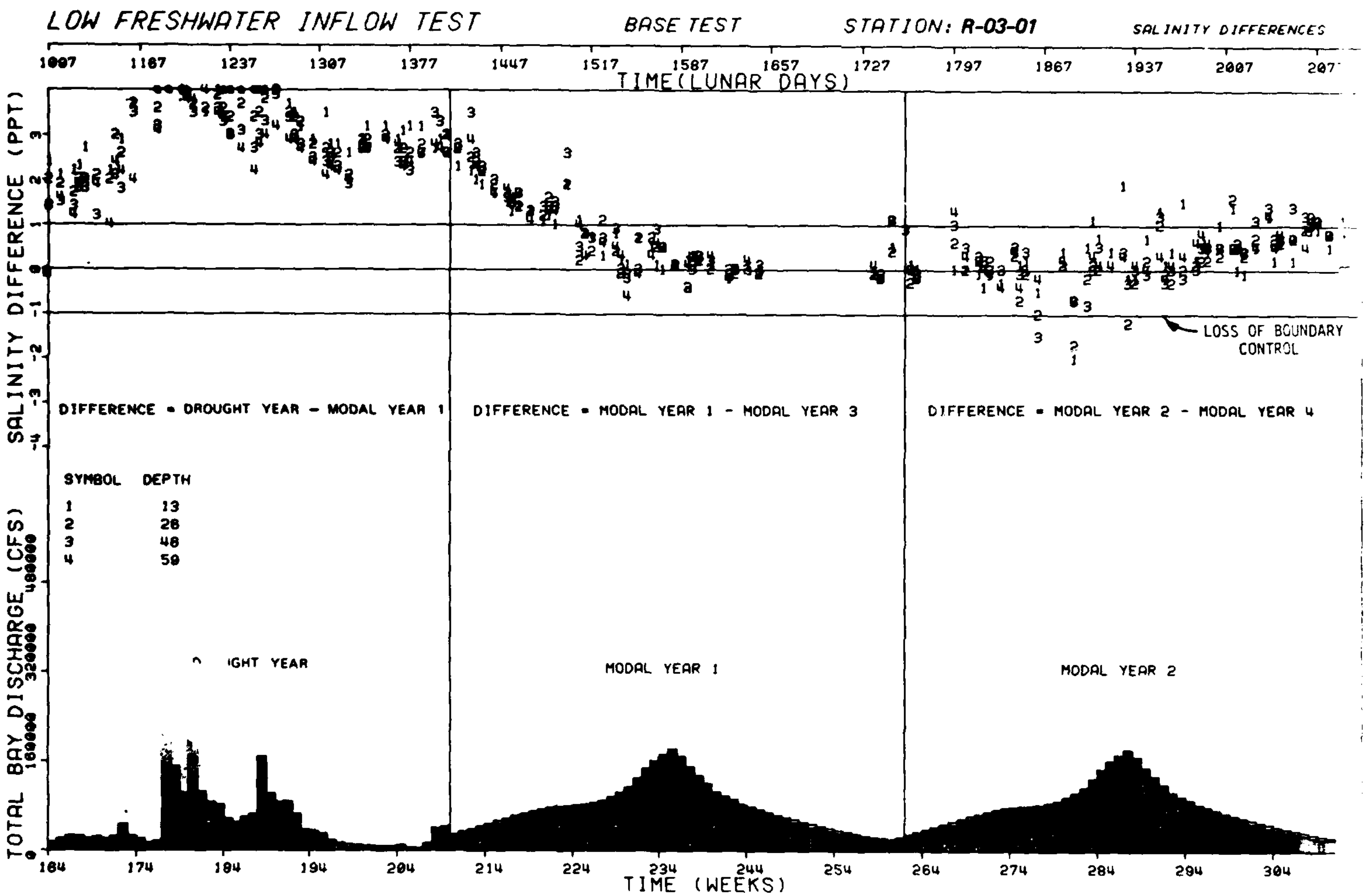

Plate 115. Dynamic normalcy plots, Base Test, sta R-03-01

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Richards, David R.
Low freshwater inflow study : Chesapeake Bay Hydraulic Model Investigation / by David R. Richards, Leif F. Gulbrandsen (Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1982.
26, [24] p., [115] p. of plates : ill. ; 27 cm. -- (Technical report : HL-82-3)
Cover title.
"January 1982."
Final report.
"Prepared for U.S. Army Engineer District, Baltimore."

1. Chesapeake Bay. 2. Fresh water. 3. Hydraulic models. 4. Water consumption. I. Gulbrandsen, Leif F. II. United States. Army. Corps of Engineers. Baltimore District. III. U.S. Army Engineer Waterways Experiment Station. Hydraulics Laboratory. IV. Title V. Series:

Richards, David R.
Low freshwater inflow study : Chesapeake Bay : ... 1982.
(Card 2)

Technical report (U.S. Army Engineer Waterways Experiment Station) ; HL-82-3.
TA7.W34 no.HL-82-3

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